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LIST OF JOURNALS.

In 1907 Abstracts were made from the following Journals. An asterisk (*) indicates that the Journals so marked were received only occasionally.

ABBREVIATION.	FULL TITLE.	PRICE.	PUBLISHERS, OR AGENTS.
*Acad. Roy. Belg., Bull.	Bulletin de la classe des sciences de l'Academie royale de Belgique	—	Published by the Academy
Acad. Sci. Cracovie, Bull.	Bulletin de l'Académie des Sciences de Cracovie	Single copy, 90 centimes; 8 francs per annum	Librairie de la Société anonyme polonaise, Cracovie
Acad. Sci. St. Pétersbourg, Bull.	Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg	Single copy, 2 marks, 50 pfennigs	Published by the Academy
Acad. Sci. St. Pétersbourg, Mém.	Mémoires de l'Académie Impériale des Sciences de St. Pétersbourg	—	Published by the Academy
*Accad. Gioenia, Atti	Atti dell' Accademia Gioenia di scienze naturali, Catania	—	Published by the Academy
Accad. Lincei, Atti	Atti della R. Accademia dei Lincei, Roma	—	Ulrico Hoepli, Milan, Italy
*Accad. Sci. Fis. Mat. Napoli, Rendiconti	Rendiconti dell' Accademia delle scienze, fisiche e matematiche, Napoli	—	Published by the Academy
Accad. Sci. Torino, Atti	Atti della R. Accademia delle Scienze di Torino	—	Published by the Academy
Akad. Wiss. Wien, Sitz. Ber.	Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Classe, Wien	Varies for separate copies	Alfred Hölder, Rothenthurmstrasse 13, Vienna
Amer. Acad., Proc.	Proceedings of the American Academy of Arts and Sciences	—	Published by the Academy, 28, Newbury Street, Boston
Amer. Chem. Journ.	American Chemical Journal	Single copy, 50 cents; \$5.50 per annum, post free	Johns Hopkins Press, Baltimore, U.S.A.
Amer. Chem. Soc., Journ.	Journal of the American Chemical Society	\$8 per annum	Eschenbach Printing Co., Easton, Pa.
Amer. Electrochem. Soc., Trans.	Transactions of the American Electrochemical Society	\$3 per volume	2910, North Sixteenth Street, Philadelphia, Pa.
Amer. Inst. Elect. Engin., Proc.	Proceedings of the American Institute of Electrical Engineers	Single copy, 50 cents; \$6 per annum	Published by the Institute, 33, West Thirty-Ninth Street, New York.

These publications can be obtained from Messrs. WILLIAMS and NORGATE, 14, Henrietta Street, W.C.

ABBREVIATION.	FULL TITLE.	PRICE.	PUBLISHERS, OR AGENTS.
Amer. Inst. Mining Engineers, Bull.	Bi-Monthly Bulletin of the American Institute of Mining Engineers	—	Published by the Institute, at S.W. Corner of Seventh and Cherry Streets, Philadelphia, Pa.
Amer. Journ. Sci.	The American Journal of Science	$6.40 per ann., post free.	The Tuttle, Morehouse & Taylor Co., 123, Temple Street, New Haven, Connecticut, U.S.A.
*Amer. Phil. Soc., Proc.	Proceedings of the American Philosophical Society	—	Published by the Society, No. 104, South Fifth Street, Philadelphia, U.S.A.
Amer. Soc. Mech. Engin., Trans.	Transactions of the American Society of Mechanical Engineers (now Proceedings)	—	Published by the Society, 29, West Thirty-ninth Street, New York
Ann. d. Physik	Annalen der Physik	45 marks per annum	J. A. Barth, Rossplatz, 17, Leipzig
Annal. Chim. Phys.	Annales de Chimie et de Physique	36 francs per annum	Gauthier-Villars, Quai des Grands-Augustins 55, Paris
*Ann. Gewerbe-u. Bauwesen	Annalen für Gewerbe- und Bauwesen	—	Published by Glaser, Berlin
Annal. Scientifiques de l'Univ. de Jassy	Annales Scientifiques de l'Universite de Jassy	10 francs per volume	Dr. Hurmuzescu, The University, Jassy
*Annal. Soc. Sci. de Bruxelles	Annales de la Société Scientifique de Bruxelles (Louvain)	20 francs per annum	P. Mansion, 6, Quai des Dominicians, Gand
Archiv. Musée Teyler	Archives du Musée Teyler, Haarlem	—	Les Héretiers Loosjes, Haarlem, Holland
Achiv Post Tele.	Archiv für Post und Telegraphie	—	Published by the Reichs-Postamt, Berlin
Archives d'Él. Médicale	Archives d'Électricité Médicale	Single copy, 1.25 francs; 22 francs per annum	J. Hamel, Rue du Temple, 6 bis, Bordeaux
Archives Néerlandaises	Archives Néerlandaises des Sciences Exactes et Naturelles	6 fl. per volume	Sec. Dutch Society of Sciences, Haarlem.
Archives des Sciences	Archives des Sciences. Physiques et Naturelles, Genève	Single copy, 2.50 francs; 25 francs per annum	Bureau des Archives, 18, rue de la Pélisserie, Geneva
*Ark. för Mat. Astron. och Fysik, Stockholm	Arkiv för Matematik, Astronomi och Fysik, Stockholm	—	Published by the Academy
*Arkiv Kem. Min. Geol. Stockholm	Arkiv för Kemi, Mineralogi och Geognosi, Stockholm	—	Published by the Academy
Assoc. Ing. Él. Liége, Bull.	Association des Ingénieurs Électriciens, Bulletin, Institut Electrotechnique Montefiore, Liége	20 francs per annum	Rue Sainte-Gilles, 31, Liége, Belgium
*Assoc. of Engineering Societies, Journ.	Journal of the Association of Engineering Societies	—	—

These publications can be obtained from Messrs. WILLIAMS and NORGATE, 14, Henrietta Street, W.C.

LIST OF JOURNALS—*continued.*

ABBREVIATION.	FULL TITLE.	PRICE.	PUBLISHERS, OR AGENTS.
*Astronom. Nachr.	Astronomische Nachrichten	—	—
Astrophys. Journ.	The Astrophysical Journal	Single copy, 50 cents; 19s. per annum	The University of Chicago Press, Chicago, and W. Wesley & Son, 28, Essex Street, Strand, W.C.
Atti dell' Assoc. Elettr. Ital.	Atti della Associazione Elettrotecnica Italiana	20 lire per annum	Sede Centrale, 2, Via Tommaso Grossi, Milan
Automobile Club Journ.	The Royal Automobile Club Journal and Motor Union Gazette	Single copy, 6d.	18, Down Street, London, W.
Automotor Journ.	The Automotor Journal	Single copy, 3d.; 14s. per annum	F. King & Co., Ltd., 44, St. Martin's Lane London, W.C.
Beibl. Ann. d. Physik	Beiblätter zu den Annalen der Physik	24 marks per annum	J. A. Barth, Rossplatz 17, Leipzig
Ber. Deut. Chem. Gesell.	Berichte der Deutschen Chemischen Gesellschaft	—	R. Friedländer & Sohn, Carlstrasse 11, Berlin, N.W.
British Optical Journ.	The British Optical Journal	Single copy, 4d.; 5s. per annum	58B, Hatton Garden, London, E.C.
*Bull. Acad. Roy. Belg.	Bulletin de la Classe des Sciences de l'Académie Royale de Belgique	—	—
*Bull. Soc. Chim.	Bulletin de la Société Chimique de France	33 francs per annum	Masson & Cie, 120, Boulevard Saint-Germain, Paris
Bull. Soc. d'Encouragement	Bulletin de la Société d'Encouragement pour l'Industrie Nationale	36 francs per annum	Published by the Society, 44, Rue de Rennes, Paris
Bull. Technologique	Bulletin Technologique	—	Imprimerie Chaix, Rue Bergère, 20, Paris
*Bureau of Standards, Bull.	Bulletin of the Bureau of Standards	—	Government Printing Office, Washington
Cambridge Phil. Soc., Proc.	Proceedings of the Cambridge Philosophical Society	Single copy, 3s. 6d.	C. F. Clay, Fetter Lane, E.C.
Cambridge Phil. Soc., Trans.	Transactions of the Cambridge Philosophical Society	Single copy, 7s. 6d.	C. F. Clay, Fetter Lane, E.C.
Canad. Elect. News	Canadian Electrical News and Engineering Journal	Single copy, 10 cents; $1.50 per annum	C. H. Mortimer Publishing Co., Ltd., 106–109, Confederation Life Building, Toronto, Canada
*Canad. Inst., Trans.	Transactions of the Canadian Institute	Single copy, $2.00	Published by the Murray Printing Co., 11–13, Jordan Street, Toronto
Cassier	Cassier's Magazine	Single copy, 1s.; 12s. per annum, post free	The Louis Cassier Co., Ltd., 33, Bedford Street, Strand, W.C.

These publications can be obtained from Messrs. WILLIAMS and NORGATE, 14, Henrietta Street, W.C.

ABBREVIATION.	FULL TITLE.	PRICE.	PUBLISHERS, OR AGENTS.
Centralblatt Accumulatoren	Centralblatt für Accumulatoren- Technik und verwandte Gebiete	3 marks 50 pf. per quarter	Dr. Franz Peters, Gross-Lichterfelde-Ost, Wilhelmstrasse, 26, Germany
*Centralblatt. Min.	Centralblatt für Mineralogie, Geologie und Paläontologie	—	Published by Bauer, Stuttgart
Chem. and Metallurgical Soc., S. Africa, Journ.	The Journal of the Chemical, Metallurgical, and Mining Society of South Africa	Single copy, 2s.; £1 4s. per annum	F. Rowland, 5 & 8, Corporation Buildings, Rissik Street, Johannesburg
*Chem. Centralblatt	Chemisches Centralblatt	2 vols. yearly, 36 marks per vol.	R. Friedländer & Sohn, Carlstrasse 11, Berlin, N.W.
Chem. News	The Chemical News and Journal of Physical Science	Single copy, 4½d.; £1 per annum, post free	16, Newcastle Street, Farringdon Street, E.C.
Chem. Soc., Journ.	Journal of the Chemical Society	£2 per annum	Gurney & Jackson, 10, Paternoster Row, E.C.
Chem. Soc., Proc.	Proceedings of the Chemical Society	—	Gurney & Jackson, 10, Paternoster Row, E.C.
Coll. Sci. Engin., Mem. Kyōtō	Kyōtō Imperial University College of Science and Engineering, Memoirs	—	Kyōtō Imperial University, Kyōtō, Japan
Chem. Zeit.	Chemiker Zeitung	7 marks per quarter	Chemiker Zeitung, Cöthen, Anhalt
Comptes Rendus	Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences	44 francs per annum	Gauthier - Villars, Quai des Grands-Augustins, 55, Paris
Deutsch. Phys. Gesell., Verh.	Berichte der Deutschen Physikalischen Gesellschaft	8 marks per annum	Fr. Vieweg ŭ. Sohn, Verlagsbuchhandlung, Braunschweig, Germany
Écl. Électr.	L'Éclairage Électrique (Now [1908] La Lumière Electrique)	Single copy, 1 fr. 50; 50 francs per annum, post free	40, Rue des Écoles, Paris
Elect. Engin.	The Electrical Engineer	Single copy, 3d.; 13s. per annum, post free	139 & 140, Salisbury Court, Fleet Street, E.C.
Elect. Engineering	Electrical Engineering	Single copy, 6d.; £1 1s. 6d. per annum, post free	203–206, Temple Chambers, London, E.C.
Elect. Journ.	The Electric Journal	15 cents per copy; $1½ per annum	Published by The Electric Club, 422–424, Sixth Avenue, Pittsburg, Pa., & 17, Bouverie Street, London, E.C.
Elect. Mag.	The Electrical Magazine	10s. 6d. per annum, post free	Electrical Publishing Co., Ltd., Bazaar Buildings, Drury Lane, London, W.C.
Elect. Rev.	The Electrical Review (London)	Single copy, 4d.; 19s. 6d. per annum, post free	H. Alabaster, Gatehouse & Co., 4, Ludgate Hill, E.C.
Elect. Rev., N.Y.	Electrical Review (New York)	Single copy, 10 cents; $6 per annum	Times Buildings, 13–21, Park Row, New York, and H. W. Hall, 42, Old Broad Street, London, E.C.

These publications can be obtained from Messrs. WILLIAMS and NORGATE, 14, Henrietta Street, W.C.

LIST OF JOURNALS—*continued.*

ABBREVIATION.	FULL TITLE.	PRICE.	PUBLISHERS, OR AGENTS.
Electrical Times	The Electrical Times, with which is incorporated Lightning	Single copy, 2d.; 10s. 6d. per annum	8, Bream's Buildings, Chancery Lane, London, E.C.
Electrical World	Electrical World, with which are incorporated The Electrical Engineer and The American Electrician	Single copy, 10 cents; 25s. per annum; or Monthly Edition, 8s. per annum	McGraw Publishing Co., 239, West Thirty-Ninth Street, New York, and Hastings House, Norfolk Street, Strand, London
Electrician	The Electrician	Single copy, 6d.; 26s. per annum	1, 2, & 3, Salisbury Court, Fleet Street, E.C.
Electricien	L'Électricien	Single copy, 50 centimes; 25 francs per annum	L. de Soye et Fils, Rue des Fossés-St.-Jacques 18, Paris
Electrochem. Ind., N.Y.	Electrochemical and Metallurgical Industry, New York	Single copy, 25 cents; $2 per annum	Electrochemical Publishing Company, 239, West Thirty-Ninth Street, New York City
Elektrotechnik u. Maschinenbau	Elektrotechnik und Maschinenbau	30 francs per annum, post free	Nibelungengasse, 7, Vienna I.
Elektrische Kraftbetr. u. Bahnen	Elektrische Kraftbetriebe u. Bahnen	19 marks 60 pfg. per annum	R. Oldenbourg, Glückstrasse, 8, Munich
Elekt. Runds.	Elektrotechnische und polytechnische Rundschau	20 marks per annum	Bonness & Hachfeld, Hohenzollernstrasse, 3, Potsdam, Germany
Elektrochem. Zeitschr.	Elektrochemische Zeitschrift	18 marks 40 pfg. per annum	M. Krayn, Kurfürstenstrasse, 11, Berlin, W., 57
*Electrotechn. Anzeiger	Elektrotechnischer Anzeiger	18 marks per annum	F. A. Günther & Sohn, Lützowstrasse, 6, Berlin, W., 35
Elektrotechn. Zeitschr.	Elektrotechnische Zeitschrift (Centralblatt für Elektrotechnik)	20 marks per annum	J. Springer, Monbijouplatz, 3, Berlin, N., 24
Elettricista, Rome	L'Elettricista	16s. per annum	Via Cavour 224 Rome
Elettricità, Milan	L'Elettricità	Single copy, 50 cents; 20 fr. per annum	12, Foro Bonaparte, Milan, Italy
Engineer	The Engineer (London)	Single copy, 6½d. post free; £1 9s. per annum, post free	33, Norfolk Street, Strand, W.C.
Engineering	Engineering	Single copy, 6½d., double No. with Index, 1s. 0½d. post free; £1 9s. 2d. per annum, post free	35 & 36, Bedford Street, Strand, W.C.

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Abbreviation.	Full Title.	Price.	Publishers, or Agents.
Eng. Club Phil., Proc.	Proceedings of the Engineers' Club of Philadelphia	Published quarterly; $2 per volume	1122, Girard Street, Philadelphia
Eng. Mag.	The Engineering Magazine	Single copy, 1s.; 12s. 6d. per annum, post free	Kean Street, Aldwych, London, W.C.
Eng. News	Engineering News	Single copy, 15 cents; $5 per annum	220, Broadway, New York
Eng. Record	The Engineering Record	Single copy, 10 cents; 25s. per annum	McGraw Publishing Co., 239, West Thirty-Ninth Street, New York, & Hastings House, Norfolk Street, Strand, London, W.C.
Eng. Rev.	The Engineering Review	Single copy, 6d.; 9s. per annum, post free	104, High Holborn, W.C.
Faraday Soc., Trans.	Transactions of the Faraday Society	10s. 6d. per copy	Published by the Society, 82, Victoria Street, S.W.
France Automobile	La France Automobile	Single copy, 50 centimes; 20 francs per annum	68, Avenue de la Grande-Armée, Paris
Frank. Inst., Journ.	Journal of the Franklin Institute	Single copy, 50 cents; $5 per annum	Franklin Institute, Philadelphia
Gasmotorentechnik	Die Gasmotorentechnik	11 marks per annum	Boll & Pockardt, Georgenstrasse 23, Berlin, N.W., 7
Gazzetta Chim. Ital.	Gazzetta della Societa Chimica Italiana	44 lire per annum	Published by the Society, Via Panisperna 89, Rome
*Gesell. Naturw. Marburg, Sitzber.	Sitzungsberichte der Gesellschaft zür Beförderung der gesamten Naturwissenschaften in Marburg	——	[By the Society]
Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse	Nachrichten von der Kgl. Gesellschaft der Wissenschaften zu Göttingen, Mathematisch-physikalische Klasse	——	Lüder Horstmann, Göttingen, Germany
Glückauf	Glückauf Berg- und hüttenmannische Zeitschrift	9 marks quarterly	Published by the Society for bergbauliche Interessen im Oberbergamtsbezirk Dortmund, Essen-Ruhr, Germany
Houille Blanche	La Houille Blanche	Single copy, 1 fr. 25 cents; 15 francs per annum	A. Gratier & J. Rey, Grande-Rue 23 Grenoble
Ind. Élect.	L'Industrie Électrique	Single copy, 1 franc; 26 francs per annum	A. Lahure, 9, Rue de Fleurus, Paris
Ind. Électrochim.	L'Industrie Électrochimique	Single copy, 1 franc; 12 francs per annum	H. Becker, 5, Rue Guy-Patin, Paris

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LIST OF JOURNALS—*continued.*

ABBREVIATION.	FULL TITLE.	PRICE.	PUBLISHERS, OR AGENTS.
Inst. Civ. Engin., Proc.	Proceedings of the Institution of Civil Engineers	—	Published by the Institution, Great George Street, London, S.W.
Inst. Elect. Engin., Journ.	Journal of the Institution of Electrical Engineers	Single copy, 5s.	E. & F. N. Spon, Ltd., 57, Haymarket, S.W.; and Spon & Chamberlain, 123, Liberty Street, New York
Inst. Engin. and Shipbuilders, Trans.	Transactions of the Institution of Engineers and Shipbuilders in Scotland	—	Published by the Institution, 207, Bath Street, Glasgow
Inst. Mech. Engin., Proc.	Proceedings of the Institution of Mechanical Engineers	—	Published by the Institution, Storey's Gate, St. James's Park, London, S.W.
Inst. Naval Architects, Trans.	Transactions of the Institution of Naval Architects	42s. per annum	5, Adelphi Terrace, Strand, London, W.C.
*Int. Rly. Congress, Bull.	Bulletin of the International Railway Congress	—	—
Iron and Steel Inst., Journ.	Journal of the Iron and Steel Institute	32s. per annum	E. & F. N. Spon, Ltd., 57, Haymarket, S.W.
Jahrbuch d. Drahtlosen Telegraphie	Jahrbuch der Drahtlosen Telegraphie und Telephonie	Quarterly; 20 marks per annum	S. Hirzel, Leipzig
*Jahrbuch d. Radioakt. u. Elektrotonik	Jahrbuch der Radioaktivität und Elektrotonik	Quarterly; 12–16 marks per annum	S. Hirzel, Leipzig
Jahrb. d. Schweiz. Elektrot. Vereins	Jahrbuch des Schweizerischen Elektrotechnischen Vereins	—	Published by the Society, Zürich
*Journ. Chim. Phys.	Journal de Chimie Physique	25 francs per annum, post free	Gauthier-Villars, 55, Quai des Grands-Augustins, Paris
Journ. Phys. Chem.	The Journal of Physical Chemistry	$4 per annum	Published at Cornell Univ., Ithaca, U.S.A.
Journ. de Physique	Journal de Physique	18 fr. per ann., post free	M. Sandoz, Boulevard Arago 97, Paris
*Journ. f. Gasbeleucht.	Journal für Gasbeleuchtung	—	Schilling, München
*Journ. Prakt. Chemie	Journal für Praktische Chemie	24 marks per annum	J. A. Barth, Rossplatz 17, Leipzig
Journ. Télégraph.	Journal Télégraphique	Single copy, 50 centimes; 5 francs per annum	Bureau International des Administrations Télégraphiques, Berne
Jurn. Russk. Fisik.-Chimičesk. Obščestva	Jurnal Russkago Fisiko-Chimičeskago Obščestva	9 roubles per annum	Published by the Russian Physico-Chemical Society, Imperial University, St. Petersburg
K. Bayer. Akad., München, Ber.	Königliche Bayerische Akademie der Wissenschaften, Sitzungsberichte (Mathematisch-Physikalische Klasse)	—	Published by the Academy

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ABBREVIATION.	FULL TITLE.	PRICE.	PUBLISHERS, OR AGENTS.
Kongl. Danske Vidensk. Selsk. Kjöbenhavn, Förh.	Öfversigt over Det Kongelige Danske Videnskabernes Selskabs Förhandlinger	5 kr. per annum...........	Andr. F. Höst og Sön, Copenhagen
Königl. Materialprüfungsamt, Mitt.	Mitteilungen aus dem königlichen Materialprüfungsamt zu Gross-Lichterfelde-West, Berlin	12 marks per annum......	J. Springer, Verlagsbuchhandlung, Monbijouplatz, 3, Berlin, N.
Konink. Akad. Wetensch. Amsterdam, Versl.	Verslag van de gewone vergadering der Wis-en Natuurkundige afdeeling der Koninklijke Akademie van Wetenschappen te Amsterdam	—	Published by the Academy
Konink. Acad. Wetensch. Amsterdam, Proc.	—	—	Published by the Academy
*Le Radium	Le Radium, la Radioactivité et les Radiations	Single copy, 1 franc; 12s. 6d. per annum	Masson & Cie, 120, Boulevard Saint-Germain, Paris
*Liebig's Ann. d. Chemie	Liebig's Annalen der Chemie	24 marks per annum......	C. F. Winter, Leipzig
Locomotion Automobile	La Locomotion Automobile	Single copy, 50 centimes; 23 francs per annum	15, Rue Bouchut, Paris
Manchester Lit. and Phil. Soc., Mem.	Memoirs and Proceedings of the Manchester Literary and Philosophical Society	Varies for separate parts	36, George Street, Manchester
Mech. Eng.............................	The Mechanical Engineer....................	Single copy, 3d.; 12s. 6d. per annum, post free	53, New Bailey Street, Manchester
Metallurgie............................	Metallurgie	6 marks per quarter	W. Knapp, Mühlweg, 19, Halle a. S., Saale, Germany
*Meteorolog. Zeitschr.	Meteorologische Zeitschrift	—	[Berlin]
*Monatsh. f. Chemie	Manatshefte für Chemie.......................	—	[Vienna]
Monthly Weather Rev..............	Monthly Weather Review.....................	Single copy, 20 cents; $2.50 per annum	Published by the U.S. Weather Bureau, Washington, D.C.
Motor Car Journ.	The Motor Car Journal	Single copy, 1d.; 6s. 6d. per annum	Cordingley & Co., 27–33, Charing Cross Road, W.C.
Motorwagen	Der Motorwagen................................	22 marks 80 pfg. per annum	M. Krayn, Kurfürstenstrasse, 11, Berlin, W. 57
*Municipal Journal and Engineer	Municipal Journal and Engineer	Single copy, 2d............	Salisbury Square, Fleet Street, E.C.
N. Cimento.............................	Nuovo Cimento	20 lire per annum	A. Lavacchini, Via Gino Capponi 3, Florence
Nature..................................	Nature	Single copy, 6d.; 28s. per annum	Macmillan & Co., Ltd., St. Martin's Street, London, W.C.

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LIST OF JOURNALS—*continued.*

ABBREVIATION.	FULL TITLE.	PRICE.	PUBLISHERS, OR AGENTS.
Inst. Civ. Engin., Proc.	Proceedings of the Institution of Civil Engineers	—	Published by the Institution, Great George Street, London, S.W.
Inst. Elect. Engin., Journ.	Journal of the Institution of Electrical Engineers	Single copy, 5s.	E. & F. N. Spon, Ltd., 57, Haymarket, S.W.; and Spon & Chamberlain, 123, Liberty Street, New York
Inst. Engin. and Shipbuilders, Trans.	Transactions of the Institution of Engineers and Shipbuilders in Scotland	—	Published by the Institution, 207, Bath Street, Glasgow
Inst. Mech. Engin., Proc.	Proceedings of the Institution of Mechanical Engineers	—	Published by the Institution, Storey's Gate, St. James's Park, London, S.W.
Inst. Naval Architects, Trans.	Transactions of the Institution of Naval Architects	42s. per annum	5, Adelphi Terrace, Strand, London, W.C.
*Int. Rly. Congress, Bull.	Bulletin of the International Railway Congress	—	—
Iron and Steel Inst., Journ.	Journal of the Iron and Steel Institute	32s. per annum	E. & F. N. Spon, Ltd., 57, Haymarket, S.W.
Jahrbuch d. Drahtlosen Telegraphie	Jahrbuch der Drahtlosen Telegraphie und Telephonie	Quarterly; 20 marks per annum	S. Hirzel, Leipzig
*Jahrbuch d. Radioakt. u. Elektrotonik	Jahrbuch der Radioaktivität und Elektrotonik	Quarterly; 12–16 marks per annum	S. Hirzel, Leipzig
Jahrb. d. Schweiz. Elektrot. Vereins	Jahrbuch des Schweizerischen Elektrotechnischen Vereins	—	Published by the Society, Zürich
*Journ. Chim. Phys.	Journal de Chimie Physique	25 francs per annum, post free	Gauthier-Villars, 55, Quai des Grands-Augustins, Paris
Journ. Phys. Chem.	The Journal of Physical Chemistry	$4 per annum	Published at Cornell-Univ., Ithaca, U.S.A.
Journ. de Physique	Journal de Physique	18 fr. per ann., post free	M. Sandoz, Boulevard Arago 97, Paris
*Journ. f. Gasbeleucht.	Journal für Gasbeleuchtung	—	Schilling, Münich
*Journ. Prakt. Chemie	Journal für Praktische Chemie	24 marks per annum	J. A. Barth, Rossplatz 17, Leipzig
Journ. Télégraph.	Journal Télégraphique	Single copy, 50 centimes; 5 francs per annum	Bureau International des Administrations Télégraphiques, Berne
Jurn. Russk. Fisik.-Chimičesk. Obščestva	Jurnal Russkago Fisiko-Chimičeskago Obščestva	9 roubles per annum	Published by the Russian Physico-Chemical Society, Imperial University, St. Petersburg
K. Bayer. Akad., München, Ber.	Königliche Bayerische Akademie der Wissenschaften, Sitzungsberichte (Mathematisch-Physikalische Klasse)	—	Published by the Academy

These publications can be obtained from Messrs. WILLIAMS and NORGATE, 14, Henrietta Street, W.C.

ABBREVIATION.	FULL TITLE.	PRICE.	PUBLISHERS, OR AGENTS.
Kongl. Danske Vidensk. Selsk. Kjöbenhavn, Förh.	Öfversigt over Det Kongelige Danske Videnskabernes Selskabs Förhandlinger	5 kr. per annum...........	Andr. F. Höst og Sön, Copenhagen
Königl. Materialprüfungsamt, Mitt.	Mitteilungen aus dem königlichen Materialprüfungsamt zu Gross-Lichterfelde-West, Berlin	12 marks per annum......	J. Springer, Verlagsbuchhandlung, Monbijouplatz, 3, Berlin, N.
Konink. Akad. Wetensch. Amsterdam, Versl.	Verslag van de gewone vergadering der Wis-en Natuurkundige afdeeling der Koninklijke Akademie van Wetenschappen te Amsterdam	—	Published by the Academy
Konink. Acad. Wetensch. Amsterdam, Proc.	—	—	Published by the Academy
*Le Radium	Le Radium, la Radioactivité et les Radiations	Single copy, 1 franc; 12s. 6d. per annum	Masson & Cie, 120, Boulevard Saint-Germain, Paris
*Liebig's Ann. d. Chemie	Liebig's Annalen der Chemie	24 marks per annum......	C. F. Winter, Leipzig
Locomotion Automobile	La Locomotion Automobile	Single copy, 50 centimes; 23 francs per annum	15, Rue Bouchut, Paris
Manchester Lit. and Phil. Soc., Mem.	Memoirs and Proceedings of the Manchester Literary and Philosophical Society	Varies for separate parts	36, George Street, Manchester
Mech. Eng............................	The Mechanical Engineer....................	Single copy, 3d.; 12s. 6d. per annum, post free	53, New Bailey Street, Manchester
Metallurgie............................	Metallurgie	6 marks per quarter	W. Knapp, Mühlweg, 19, Halle a. S., Saale, Germany
*Meteorolog. Zeitschr.	Meteorologische Zeitschrift	—	[Berlin]
*Monatsh. f. Chemie	Manatshefte für Chemie.......................	—	[Vienna]
Monthly Weather Rev...............	Monthly Weather Review.....................	Single copy, 20 cents; $2.50 per annum	Published by the U.S. Weather Bureau, Washington, D.C.
Motor Car Journ.	The Motor Car Journal	Single copy, 1d.; 6s. 6d. per annum	Cordingley & Co., 27–33, Charing Cross Road, W.C.
Motorwagen	Der Motorwagen...............................	22 marks 80 pfg. per annum	M. Krayn, Kurfürstenstrasse, 11, Berlin, W. 57
*Municipal Journal and Engineer	Municipal Journal and Engineer	Single copy, 2d............	Salisbury Square, Fleet Street, E.C.
N. Cimento............................	Nuovo Cimento	20 lire per annum	A. Lavacchini, Via Gino Capponi 3, Florence
Nature.................................	Nature	Single copy, 6d.; 28s. per annum	Macmillan & Co., Ltd., St. Martin's Street, London, W.C.

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LIST OF JOURNALS—*continued.*

ABBREVIATION.	FULL TITLE.	PRICE.	PUBLISHERS, OR AGENTS.
Nova Scotian Inst., Proc. & Trans.	The Proceedings and Transactions of the Nova Scotian Institute of Science	Single copy, $¼	Published by the Institute, Halifax, Nova Scotia
Observatory	—	—	—
Öfvers. Kongl. Vet. Akad. Stockholm, Förh.	Öfversigt af Kongliga Vetenskapsakademiens Förhandlingar, Stockholm	—	Published by the Academy
Phil. Mag.	The London, Edinburgh, & Dublin Philosophical Magazine, & Journal of Science	2s. 6d. per month, occasionally 5s.	Taylor & Francis, Red Lion Court, Fleet Street, E.C.
Photographic Journ..................	The Photographic Journal....................	Single copy, 1s.	Harrison & Sons, 45, Pall Mall, S.W.
Phys. Rev.	The Physical Review	Single copy, 50 cents, double nos. 75 cents; $5 per annum	Macmillan & Co., Ltd., London, and 66, Fifth Avenue, New York
Phys. Soc., Proc.......................	The Physical Society of London, Proceedings	£1 per annum	Taylor & Francis, Red Lion Court, Fleet Street, E.C.
Physico-Mathematical Soc., Tōkyō, Proc.	Tōkyō Sūgaku-Buturigakkwai, Kizi........	—	The Tōkyō Mathematical-Physical Society, Tōkyō, Japan
Phys. Tech. Reichsanstalt, Wiss. Abh.	Wissenschaftliche Abhandlungen der Physikalisch-Technischen Reichsanstalt	30 marks per volume......	J. Springer, Verlagsbuchhandlung, Monbijouplatz 3, Berlin, N.
Phys. Zeitschr.	Physikalische Zeitschrift......................	29 marks 60 pfg. per annum, post free	S. Hirzel, Königsstrasse 2, Leipzig
Power	Power..	1s. per copy; 12s. per annum	The Hill Pub. Co., 6, Bouverie Street, Fleet Street, E.C.
Preuss. Akad. Wiss. Berlin, Sitz. Ber.	Sitzungsberichte der königlich Preussischen Akademie der Wissenschaften zu Berlin	12 marks per annum......	Königliche Akademie der Wissenschaften, Berlin
*Quekett Club, Journ.	Journal of the Quekett Microscopical Club	—	—
*Real Acad. de Ciencias, Madrid	Revista de la Real Academie de Ciencias, Madrid	—	Published by the Academy
*Real Istit. Veneto, Atti	Atti del R. Istituto veneto di scienze, lettere ed arti, Venezia	—	Published by the Academy
*Rec. trav. chim.	Receuil des Travaux chimiques des Pays-bas et de la Belgique	—	[Leiden]
Rev. Électrique	La Revue Électrique	Single copy, 1 fr. 50 c.; 30 francs per annum	Gauthier-Villars, 55, Quai des Grands-Augustins, Paris
Revue Int. d'Électrothérapie	Revue Internationale d'Electrothérapie et de Radiothérapie	Single copy, 50 centimes; 6 francs per annum	Rue Beaujon, 9, Paris

These publications can be obtained from Messrs. WILLIAMS and NORGATE, 14, Henrietta Street, W.C.

Abbreviation.	Full Title.	Price.	Publishers, or Agents.
Roentgen Soc., Journ.	The Journal of the Roentgen Society	4s. per copy; 16s. per annum	Smith & Ebbs, Ltd., Northumberland Avenue; Fenchurch Street, E.C.
Royal Astronom. Society, Monthly Notices	Monthly Notices of the Royal Astronomical Society	10s. per annum	Published by the Society, Burlington House London, W.
Roy. Dublin Soc., Proc.	Scientific Proceedings of the Royal Dublin Society	Varies for separate parts	Published by the Royal Dublin Society, Leinster House, Dublin, and Williams & Norgate, 14, Henrietta Street, Covent Garden, W.C.
Roy. Dublin Soc., Trans.	Scientific Transactions of the Royal Dublin Society	Single copy, 1s.	
Roy. Inst., Proc.	Proceedings of the Royal Institution of Great Britain	5s. per copy	Published by the Institution, 21, Albemarle Street, W.
Roy. Soc. Edinburgh, Proc.	Proceedings of the Royal Society of Edinburgh	Varies for separate papers	R. Grant & Son, 107, Princes Street, Edinburgh, and Williams & Norgate, 14, Henrietta Street, Covent Garden, London
Roy. Soc. Edinburgh, Trans.	Transactions of the Royal Society of Edinburgh	Varies for separate papers	R. Grant & Son, 107, Princes Street, Edinburgh, and Williams & Norgate, 14, Henrietta Street, Covent Garden, London
Roy. Soc. N. S. Wales, Journ. and Proc.	Journal and Proceedings of the Royal Society of New South Wales	—	5, Elizabeth Street North, Sydney, New South Wales
Roy. Soc., Phil. Trans.	Philosophical Transactions of the Royal Society of London	Varies for separate papers, from 1s.	Harrison & Sons, 45, St. Martin's Lane, London, W.C.
Roy. Soc., Proc.	Proceedings of the Royal Society of London	Varies for separate parts, from 1s. 6d.	Harrison & Sons, 45, St. Martin's Lane, London, W.C.
Roy. Soc. Victoria, Proc.	Proceedings of the Royal Society of Victoria	—	Published by the Society, Melbourne London Agents: Williams & Norgate, 14, Henrietta Street, Covent Garden, W.C.
Schweiz. Elektrot. Zeit.	Schweizerische Elektrotechnische Zeitschrift	25 francs per annum, post free	F. Amberger, Sihlhofstrasse 12, Zürich
Science	Science	Single copy, 15 cents; $5 per annum	The Macmillan Co., 66, Fifth Avenue, New York
Scientific American	Scientific American	Single copy, 10 cents; 18s. 6d. per annum, post free	Munn & Co., 361, Broadway, New York
Soc. Arts, Journ.	Journal of the Society of Arts	Single copy, 6d.	G. Bell & Sons, York House, Portugal Street, W.C.
Soc. Belge Élect., Bull.	Société Belge d'Électriciens, Bulletin Mensuel	Single copy, 2,50 frs.; 20 frs. per ann., post free	Ramlot Frères et Sœurs, 25, Rue Grétry, Brussels

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LIST OF JOURNALS—*continued.*

Abbreviation.	Full Title.	Price.	Publishers, or Agents.
Soc. Chem. Ind., Journn.	Journal of the Society of Chemical Industry	36s. per annum	Published by the Society, 59, Palace Chambers, Westminster, S,W.
*Soc. Chim. de Belgique, Bull.	Bulletin de la Société chimique de Belgique	—	—
Soc. d'Encouragement, Rev. de Métallurgie, Mém.	Société d'Encouragement, Revue de Métallurgie, Mémoires	40 francs per annum	H. Dunod and E. Pinat, 49, Quai des Grands-Augustins, Paris
Soc. Franç. Phys., Bull.	Bulletin des Séances de la Société Française de Physique	—	Published by the Society, 44, Rue de Rennes, Paris
Soc. Imp. Nat. Moscou, Bull.	Bulletin de la Société Impériale des Naturalistes de Moscou	—	J. N. Kouchnereff & Co., Pimenowskaia, Moscou
*Soc. Ing. Civ., France, Bull.	Mémoirs et Compte Rendu des Travaux de la Société des Ingénieurs Civils de France	—	Hotel de la Société, 19, Rue Blanche, Paris
Soc. Int. Élect., Bull.	Bulletin de la Société Internationale des Electriciens	Single copy, 2.50 francs; 27 francs per annum	Gauthier-Villars, Quai des Grands-Augustins, 55, Paris
Stahl u. Eisen	Stahl und Eisen. Zeitschrift für das deutsche Eisenhüttenwesen	30 marks per annum	5, Jacobistrasse, Düsseldorf, Germany
Street Rly. Journ.	Street Railway Journal	Single copy, 20 cents; 25s. per annum, post free	McGraw Publishing Co., 239, West Thirty-Ninth Street, N.Y., and Hastings House, Norfolk Street, Strand, W.C.
*Technolog. Gewerbe-Museum, Wien, Mitteil.	Mitteilungen aus dem Technologischen Gewerbe-Museum, Wien	—	—
Technology Quarterly	Technology Quarterly and Proceedings of the Society of Arts (Boston)	Single copy, 75 cents; $3 per annum	Massachusetts Institute of Technology, Boston, Mass
Terrestrial Magnetism	Terrestrial Magnetism and Atmospheric Electricity	Single copy, 75 cents; $2.75 per annum	Jennings & Graham, 220, W. Fourth St., Cincinnati
Tram. Rly. World	The Tramway and Railway World	Single copy, 1s. post free	Amberley House, Norfolk Street, W.C.
*University of Illinois, Bull.	Bulletin of the University of Illinois	—	—
*Univ. of Minnesota, Engin. Soc., Year Book	Year Book of the University of Minnesota, Engineering Society	—	—
*Verein z. Beförd. des Gewerbfleisses, Verh.	Verhandlungen des Vereins zur Beförderung des Gewerbfleisses	30 marks per annum	L. Simion, Nachf., Berlin
West. Electn.	Western Electrician (Chicago)	Single copy, 10 cents; $5 per annum	507, Marquette Building (204, Dearborn Street), Chicago

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Abbreviation.	Full Title.	Price.	Publishers, or Agents.
West. Soc. Engin., Journ.	Journal of the Western Society of Engineers	Single copy, 50 cents; $3 per volume of six numbers	Published by the Society, 1734-41, Monadnock Block, Chicago
*Zeitschr. Analyt. Chemie	Zeitschrift für Analytische Chemie	18 marks per annum	C. W. Kreidel, Wiesbaden
*Zeitschr. Angew. Chemie	Zeitschrift für Angewandte Chemie	20 marks per annum	Dr. B. Rassow, Berlin, N.
Zeitschr. Anorg. Chem.	Zeitschrift für Anorganische Chemie	Varies for separate copies. 12 marks per volume	Leopold Voss, Leipzig
*Zeitschr. f. Beleuchtungswesen	Zeitschrift für Beleuchtungswesen	40 marks per annum	—
Zeitschr. Elektrochem.	Zeitschrift für Elektrochemie und angewandte physikalische Chemie	5 marks per quarter	W. Knapp, 90, Bulowstrasse, Berlin, W. Germany
Zeitschr. ges. Turbinenwesen	Zeitschrift für das gesamte Turbinenwesen	20 marks 40 pfg. per annum	R. Oldenbourg, Glückstrasse, 8, Münich
Zeitschr. Instrumentenk.	Zeitschrift für Instrumentenkunde	} 20 marks per annum	J. Springer, Monbijouplatz 3, Berlin
Zeitschr. Instrumentenk., Beib.	Deutsche Mechaniker-Zeitung. Beiblatt zur Zeitschrift für Instrumentenkunde	}	
Zeitschr. Phys. Chem.	Zeitschrift für Physikalische Chemie	Single copy about 4s. 3d.	2 & 3, Linnéstrasse, Leipzig
Zeitschr. Vereines Deutsch. Ing.	Zeitschrift des Vereines Deutscher Ingenieure	Single copy, 1 mark 45 pfg.; 36 marks per annum, post free	J. Springer, Monbijouplatz 3, Berlin, N.
*Zeitschr. Wiss. Phot.	Zeitschrift für Wissenschaftliche Photographie, Photophysik, und Photochemie	20s. per annum	J. A. Barth, Leipzig

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ERRATA.

Section B.—ELECTRICAL ENGINEERING.

Abstract No. 11, line 3 : *for* 136, *read* 132.
Abstract No. 18, line 2 : *for* 6, *read* 7.
Abstract No. 89, line 2 : *for* 59, *read* 58.
Abstract No. 156 : *for* Gröndel, *read* Gröndal (all through).
Abstract No. 308, line 3 : *for* March 6, *read* March 16.
Abstract No. 440, line 15 : *for* 0·035, *read* 0·05.
Abstract No. 510, line 1 : *for* Electrolysis, *read* Electrolytes.
Abstract No. 582, line 3 : *for* p. 231, *read* p. 227.
Abstract No. 638 : *for* Gröndel, *read* Gröndal (all through).
Abstract No. 1055, line 1 : *read* L. A. Ferguson.
Abstract No. 1107, line 3 : *for* Poulson, *read* Poulsen.
Abstract No. 1355, line 3 : *for* 60, *read* 59.

SCIENCE ABSTRACTS.

Section B.—ELECTRICAL ENGINEERING.

JANUARY 1907.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

1. *Test of a Modern Steam Winding Engine.* **D. A. Bremner.** (Engineer 102. pp. 600–602, Dec. 14, 1906.)—Tests on a Fraser and Chalmers compound non-condensing winding engine of their own make, installed at the Sherwood Colliery, have been carried out by the builders, and the results independently worked out by the author. The cylinders are 32 and 58 in. diam. respectively, 66 in. stroke. A reheater is provided between the cylinders, and the latter were jacketed during the test. Superheating was employed. Details of winds (from 1,382 ft.) with steam consumption curves and indicator diagrams are given. The steam per shaft h.p.-hour at boiler pressures of 130 and 125 lbs. per sq. in. and 65° F. superheat was 40·7 and 40 lbs. in two tests, during which the percentage actual running time of total time 86·2 and 86·7 per cent. respectively. In two other tests, one with 70° F. superheat and 36·7 percentage running time, and the other with 105° F. superheat and 68 percentage running time, the consumption per shaft h.p.-hour was 39·82 and 38·95 lbs. respectively. This latter figure is considered to establish a record for non-condensing engines. [Compare Abstracts Nos. 70 and 71 (1907).] L. H. W.

2. *Overloaded Steam Engines.* **A. Witz.** (Écl. Électr. 49. pp. 407–417, Dec. 15, 1906. Paper read before the Soc. Ind. du Nord de la France. Ind. Élect. 15. pp. 448–451, Oct. 10, 1906. Abstract.)—The practice of working steam engines on a load above that for which they were designed increases with the growth of business and disinclination to scrap good machinery, but the question as to how far that course can be followed with safety and economy is always immanent. The author discusses minutely the effect of the dimensions given by makers in their nominal h.p. ratings of engines, and, by comparing the results of a number of tests, shows how the thermal output is affected by variation in the degree of expansion. As a general rule the consumption of steam increases very slowly, even with overloads of 20, 25, or 30 per cent., and this flexibility is the great feature of the steam engine. On the point of safety in overloading, the variation of the admission pressure

is considered, and found to be inadvisable, because, whilst it adds fresh strains to certain parts, little real gain in power is realised and less economy. Lengthening the period of admission disturbs no essential elements of the stability of the machine, and merely calls for more care in oiling the bearings. In many cases it is advisable to instal a small auxiliary engine—preferably of the turbine type—to assist at the periods of heaviest demand, or to carry the lighting circuits. Gas engines with suction producers are also useful auxiliaries, but the turbine, unlike the gas engine, has a consumption proportional to the power developed, and is preferable for auxiliary work.

F. J. R.

3. *Operating Results at the New Baltimore Steam Turbine Plant.* **B. S. Josselyn.** (Eng. Record, 54. p. 475, Oct. 27, 1906. Power, 26. pp. 783–785, Dec., 1906. Abstract of Report.)—The plant was described in Abstract No. 1220 (1906). In this article the satisfactory condition of the turbines when opened up after about a year's service is described. Notwithstanding the low load-factor (12–15 per cent.) the station, for May, 1906, averaged only 3·36 lbs. of coal per kw.-hour generated, including all coal for banking and changing boilers. This coal consisted largely of bituminous mine cuttings, very friable and resembling slack. With a better grade coal 2·6 lbs. per kw.-hour has been attained. The corresponding water consumption for May averaged 23·9 lbs. per kw.-hour, including all auxiliaries; the actual evaporation during the month (from feed temperature 180° F.) averaged 7·11 lbs. of saturated steam per lb. of coal; with the present low-grade fuel, 6¾ lbs. Using better fuel it has reached 8–8½ lbs. L. H. W.

4. *Turbine Theory.* **A. Balog.** (Zeitschr. ges. Turbinenwesen, 3. p. 481, Nov. 30, 1906.)—Starting from the fundamental equations, $pv^{\gamma} =$ constant and $\lambda = [\gamma/(\gamma-1)]pv$, the author deduces for two points on the adiabatic expansion curve $p_1^{\frac{\gamma-1}{\gamma}}/\lambda_1 = p_2^{\frac{\gamma-1}{\gamma}}/\lambda_2 =$ const. These are treated geometrically by Brauer's method, and give $(1+\tan\xi)^{\gamma} = 1+\tan\epsilon$, $(1+\tan\xi)^{\frac{\gamma-1}{\gamma}} = 1+\tan\epsilon$. If the initial values of pv and λ are known, these equations can be graphed. The author applies these curves to find the constants for a de Laval nozzle.

A. W.

5. *Efficiency of Boiler Plant.* (Engineering, 82. pp. 665–666, Nov. 16, 1906.)—This article is mainly a *résumé* of the paper by G. Wilkinson [Abstract No. 1006 (1906)], with additional arguments in favour of hotter feed and smaller boilers. Kirkaldy's live-steam feed-heater is referred to, and experiments by Bramwell and Anderson are quoted. In these F. Bramwell found that when water was raised from 58° to 200° F. in a steam-heated copper pan, the rate of heat transmission was 162 B.Th.U. per sq. ft. per 1° difference of temperature per hour, while from 200° to 212° F. the rate was 327, and 427 B.Th.U. per hour when the water was boiling. W. Anderson made similar experiments in 1872, the results of which showed the same increase.

F. J. R.

6. *Discharge of Steam through Circular Orifices.* **D. S. Jacobus.** (Science, 23. p. 766, May 18, 1906. Paper read before the Amer. Assoc. for the Advancement of Science.)—In order to observe the difference in the coefficient of discharge of steam through a single circular orifice and through a number of circular orifices in the same plate, holes of ⅜ in. diam. were bored

in a plate which was inserted in a flange union in a pipe of 2 in. diam. The single orifice was made in the centre of the plate, and when six orifices were used five others were grouped around the central one midway between the periphery of the central orifice and the inside of the pipe. The flow per orifice was about 14 per cent. greater than with a single orifice, showing an important part played by the conditions on the exhaust side of the plate. The position at which the pressure on the exhaust side was ascertained, was also an important factor, as the pressure varied considerably when measured at different distances from the plate. The pressure on the high-pressure side was about 147 lbs. per sq. in., and on the discharge side about 105 lbs. This pressure was measured at a considerable distance from the plate in order to avoid a jet action which existed at a point near the plate, and caused a less pressure there than farther out. F. J. R.

7. *Priming caused by poor Circulation.* **D. S. Jacobus.** (Science, 23. pp. 766–767, May 18, 1906. Paper read before the Amer. Assoc. for the Advancement of Science.)—In an experiment with a small vertical boiler of about 15 h.p. rated capacity, of ordinary construction, with a water-casing round a circular grate, and vertical tubes leading directly upwards from the combustion chamber to the chimney above the upper tube plate, it was found that when retarders were placed in the tubes the temperature was evenly distributed over them all, whereas without retarders the temperature of the gases from the tubes nearest the centre was much higher than that of those in the outer circumferential rows. Working normally, without retarders, the steam was dry for ordinary rates of combustion, and was slightly superheated when the boiler was forced. When the retarders were used severe priming took place, showing that the conditions of circulation were interfered with, none of the tubes being cool enough to permit them to act as downcomers. The whole of the water in the boiler was thus periodically thrown into a foaming condition, and part was ejected with the steam from the boiler.
F. J. R.

8. *Powdered Coal Firing for Steam Boilers.* **G. C. McFarlane.** (Engin. and Mining Journ. 81. pp. 901–902, 1906.)—The author gives details of an American installation of coal-dust firing. The coal is crushed by toothed rolls, and is then passed through a rotary drier, heated by the waste gases from the boiler plant. The dried coal is then crushed to the size of granulated sugar in a suitable mill, and is finally ground in a tube mill, until 95 per cent. will pass a 100-mesh sieve. This coal dust is fed into the blast-pipe of the furnace by a Buffalo blower, the nozzles of the two branches of this blast-pipe being 20 in. wide by 1¼ in. deep. The furnace is built of firebrick and is arranged in front of the boiler, being from 5 to 8 ft. in length. About 145 cub. ft. of air are required to burn 1 lb. of coal, and the chimney gases contain only from 1 to 1½ per cent. of free oxygen. The following figures are given for the comparative costs of hand-firing and coal-dust firing in America :—

Hand Firing.			*Coal-dust Firing.*		
Per day	65 tons of coal at $2.4	$156.00	Per day	58 tons of coal at $2.40	$139.20
	Labour	13.60		Labour	8.32
		$169.60			$147.52

Adding interest on capital and other charges, the comparison works out to an annual saving of $2,886 in favour of coal-dust firing; the saving of fuel per h.p.-hour being estimated at ½ lb. J. B. C. K.

9. *New Liquid Measuring Apparatus for Boiler Feed-water.* **G. B. Willcox.** (Amer. Soc. Mech. Engin., Trans. 27. pp. 711–717; Discussion, pp. 717–719, 1906.)—This apparatus consists of an upper or receiving tank and a lower or measuring tank, which latter has a vertically movable bell-float enveloping the upper end of a U-shaped water-sealed discharge pipe projecting from the bottom of the measuring tank. The bell float operates a valve in the bottom of the upper tank, and a U-shaped "trip" or small pipe branching from the top end of the discharge pipe acts as an automatic syphon, which regulates the position of the bell float, and therefore the periods of closing the inlet valve in the upper tank. Devices are introduced to prevent splashing of the water entering the upper tank by the inlet pipe, and to prevent steam from hot feed-water, when that is being measured, from interfering with the action of the apparatus. A float-actuated counter registers the number of charges measured, and a gauge glass shows the height of the charge in the measuring tank. The tank has operated continuously for many months with boiler feed-water at 205° to 210° F., and also for measuring brine in salt manufacture, the maximum error after four months' constant service as a feed-water weigher having been less than ¼ of 1 per cent. In the *discussion,* **D. S. Jacobus** inquired if the limits of error applied to the apparatus equally at full, half, and one-quarter capacity, and at different speeds of water flowing through it, and the **Author** replied in the affirmative, giving figures of tests made by H. C. Anderson at the Engineering Department of the University of Michigan. F. J. R.

GAS AND OIL ENGINES.

10. *Large Gas Engines in German Iron and Steel Industries.* **K. Reinhardt.** (Iron and Steel Inst., Journ. vol. 71, 1906. Amer. Inst. Mining Engineers, Bull. 12. pp. 1087–1168, Nov., 1906. Joint Meeting Paper. Mech. Eng. 18. pp. 268–272, Aug. 25; 307–318, Sept. 1; 332–338, Sept. 8, and pp. 370–376, Sept. 15, 1906. Eng. News, 56. pp. 352–354, Oct. 4, 1906.)—The first large gas engine in Germany was started in 1898. It was a 600-h.p. 2-cycle engine with two cylinders of the Oechelhäuser-Junker type, made by the Berlin-Anhaltische Maschinenbau-Gesellschaft of Dessau for the Hoerde Works, and is still working satisfactorily. Of 49 German smelting works, 32 now have gas engines at work and 9 have such engines ordered. The largest aggregate power at a single works amounts to 35,000 h.p. Sixteen works possess over 10,000 h.p. and 27 works have over 5,000 h.p. in actual work, few of them having any reserve engines. In March, 1906, sixteen collieries had 85 gas engines at work or being erected, of an aggregate h.p. of 30,300. Of these, 24 engines of 15,600 b.h.p. are at work, all for the production of electricity. At present 29 firms in Germany build large gas engines, and of these 21 build double-acting 4-cycle and 5 firms build 2-cycle engines, whilst 3 firms build both systems. For purifying the gas in ironworks, dry purifiers, coolers, or scrubbers, and centrifugal apparatus are employed, and frequently drying apparatus is added. The Theisen centrifugal apparatus, the Zschocke scrubber, the Dinnendahl fans, and the Bian cooler are described and illustrated. The power expended in cleaning 1,000 cub. m. of gas per hour varies mostly between 6 and 18 h.p., or from 1·8 to 4 per cent. of the power obtained

from the purified gas. The amount of water used for cleaning varies from 3 to 8 litres per cub. m. of gas. Percentage of dust in the gas after dry purification averages 4 to 6 gm. per cub. m. In some cases it is only 1 to 1·5 gm. This is reduced in most cases for working the motors, to 0·015 to 0·08 gm., and in a few works even from 0·004 to 0·005 gm. per cub. m. Apart from the consumption of water, the Theisen apparatus is approximately equal to two fans. For coke-oven gases, after recovery of the by-products, tar separators, Pelouze apparatus, rotary cleaners and filters with Laming composition, are employed to remove tar, ammonia, naphthaline, cyanide, and sulphur. In one case the percentage of sulphur was reduced from 5 gm. to 0·7 gm. per cub. m. The pressure of the gas at engines averages from 2 to 4 in. of water, and gas-holders are frequently used in ironworks in order to maintain a steady pressure. The design, details of construction, and special features of the engines made by all the principal makers, are described and illustrated by means of woodcuts and plates [see also Abstracts Nos. 148 and 408 (1906)], and the author concludes that at present it is not possible to forecast the outcome of competition between the 2-cycle and the 4-cycle systems. The peculiar conditions of German ironworks have rendered the better and less dangerous utilisation of the waste gases of their furnaces necessary, but in richer countries with more favourable conditions the matter is not so urgent.

F. J. R.

11. *Design of Blast-furnace Gas Engines in Belgium.* **H. Hubert.** (Iron and Steel Inst., Journ., vol. 71, 1906. Amer. Inst. Mining Engineers, Bull. 12. pp. 909–930, Nov., 1906. Joint Meeting Paper. Engineering, 82. pp. 129–136, July 27, 1906.)—The author traces the history of the development in size and efficiency of these engines as made by the Cockerill Co., commencing with a Simplex engine of 8 h.p. in 1895 to the 1,400-h.p. 2-cylinder double-acting and tandem engine tested by Hubert and Witz in Jan., 1906. Details of construction are shown by plates and described in the text. A comparative view of the progress is given in the following table:—

No.	Description.	Date of Trials.	Power.		Consumption of Gas (in cub. m.).		Consumption of Heat (Kg.-cals.)		Thermal Efficiency. Per Cent.
			I.H.P.	B.H.P.	Per I.H.P.	Per B.H.P.	Per I.H.P.	Per B.H.P.	
1	8-h.p. engine	1895	5·26	4	4·03	5·30	4080	5300	15·77
2	200-h.p. engine: single cyclinder, single acting, constant admission ...	July 19–20, 1898	213·9	181·82	2·830	3·329	2775·6	3625·7	22·9
3	600-h.p. engine: single cylinder, single acting, constant admission ...	March 20, 1900	825·8	670·0	2·560	3·156	2520·1	3106·8	25·2
4	200-h.p. engine: single cylinder, single acting, variable admission......	Dec. 2, 1901	246·9	215·3	2·981	3·413	2766	3172	23·0
5	1,400-h.p. engine, double acting, tandem, variable admission	Jan. 9 & 10, 1906	1755·06	1581·9	2·155	2·392 (?)	2129	2363·3	29·84

The Société de Saint Leonard is the only other company in Belgium making blast-furnace gas engines. They are constructing Koerting 2-cycle double-acting engines for the blast furnaces at Grivegnée. F. J. R.

12. *Suction Gas Engines and Gas Plants.* **H. Campbell.** (Inst. Engin. and Shipbuilders, Trans. 50. 2. (pp. 17–44), 1906–1907.)—The first portion of the paper contains some useful data of working costs of gas engines and plant applied to various purposes, consumption of water and fuel, and cost of upkeep. The following comparative table is given :—

GUERNSEY STEAM AND GAS-DRIVEN ELECTRIC STATION.
[See Abstract No. 918 (1905).]

Cost of Working, January to March, 1906.

	Steam Plant Lighting Load. Per Unit Generated.	Gas Plant Power Load. Per Unit Generated.
Coal (including pumps and forced draught)	0·391d.	0·151d.
Oil, &c.	0·027	0·046
Wages	0·209	0·136
Repairs	0·207	0·176
Total Works Costs	0·834d.	0·509d.
Units generated	164,828	162,488
Price of coal in bunkers	16s. 2d.	15s. 6d.

The latter half of the paper deals with design, and describes (with illustrations) the Campbell suction gas plant of a standard size, examples of the 2- and 4-cycle engines, various methods of governing gas engines, and the gas machinery of a tug of 100 b.h.p. plying between Rotterdam and the Rhine. F. J. R.

13. *Producer Gas Tests of the U.S. Geological Survey Coal-testing Plant.* **R. H. Fernald.** (Amer. Soc. Mech. Engin., Trans. 27. pp. 302–334; Discussion, pp. 334–342, 1906.)—Pending the official publication of the results of the plant, this paper gives, in a series of tables, the results of preliminary tests of 24 specimens of American coals, with a sketch of the plant, conditions of conducting tests, and specimens of the log and report forms adopted. The coal was in all cases consumed in a "Taylor" pressure producer, and the gas was passed through cleaning plant and utilised in a 3-cylinder Westinghouse gas engine, coupled by belt to a 6-pole 175-kw. direct-current generator. The engine at 200 r.p.m. was rated at 235 b.h.p. with producer gas. The lowest result shown in the tables is 0·89 lb. dry combustible used in the producer per b.h.p.-hour developed at engine, and the highest 1·58 lb. These are equivalent to 1·39 lb. and 3·42 lbs. coal as fired per e.h.p.-hour developed at switchboard. A comparison with results of the coals as used under boilers in steam trials, as reported on by L. P. Breckenridge, is given in a table, the average of these showing a ratio of 2·57 in favour of the gas-producer plant. In the *discussion,* **F. E. Junge** described German developments in producer practice with bituminous coals, instancing the Güldner suction plant, which produces 1 b.h.p.-hour with 0·73 lb. coal of 13,860 B.Th.U. per lb. [see Abstract No. 1890 (1906)]. Efforts are being made to use city refuse, mixed with powdered lignite, in producers. **F. R. Hutton** urged the codification of procedure in gas-

producer tests. The **Author**, in reply, sketched the probable course of the investigations to be carried out in future. Purifiers for sulphur and economisers for pre-heating the air had been discarded. [See Abstract No. 906 (1906).] F. J. R.

14. *Reeve's Thermo-dynamic Cycle.* (West. Electn. 39. pp. 352–353, Nov. 3, 1906.)—The theoretical Otto cycle is represented by a diagram in which ordinates represent absolute temperatures of the medium and abscissæ represent entropy, or what may be called the "heat weight" or factor of extent. In practice, from various causes, only about half the area of the diagram is available for mechanical work. Compared with this is another diagram, showing what is called the "Joule" cycle, in which there is adiabatic compression to the full working pressure, addition of heat under constant pressure, adiabatic expansion to atmospheric pressure, and abstraction of heat at atmospheric pressure, whereby the area representing mechanical work is considerably increased. S. A. Reeve has attempted to render the Joule cycle practically available by adopting an initial pressure of 250 to 500 lbs. per sq. in., produced by the explosion of compressed gases in a chamber in contact with water, and utilising the mixed steam and hot gases in a cylinder like that of an ordinary steam engine. The expanded gases then pass into a low-pressure cylinder, which is utilised to drive the compressors direct, and thence they are exhausted into a condenser or into the atmosphere. A diagrammatic illustration of the apparatus proposed also accompanies the paper. F. J. R.

AUTOMOBILISM.[1]

15. *Use of Steam Turbines for Propelling Motor Coaches.* **H. Holzwarth.** (Zeitschr. ges. Turbinenwesen, 3. pp. 458–460, Nov. 20, and pp. 473–478, Nov. 30, 1906.)—The author deals with the different considerations involved, and estimates theoretically the weight, steam consumption, and starting torque of a turbine-propelled motor coach, under three heads: I. Fourteen atm. steam pressure, 200 b.h.p., exhaust to atmosphere, single-stage turbine for 6,000 r.p.m. built in between the wheels of a bogie truck; normal steam consumption 18 kg. per b.h.p.-hour. Starting pull can be increased to 6·7–8·9 times normal by using 3–4 rows of nozzles, one only being used normally. Weight without transmission, 1,600 kg. II. Simple multiple-stage turbine without special starting device would use 21·7 kg. steam per b.h.p.-hour, 200 b.h.p., 4,000 r.p.m., when a starting pull 7·25 times the normal torque is required. Each turbine drives a worm-shaft actuating both wheels of a bogie truck. Weight of turbine, 3,000 kg. III. A multiple-stage turbine, with special valve arrangement, requires 18·3 kg. steam per b.h.p.-hour at 200 b.h.p. and 4,000 r.p.m. if it is to exert a starting pull equal to 7·7 times normal. Weight of turbine without transmission, 4,800 kg. L. H. W.

REFERENCE.

16. *Leblanc System of Condensers.* (Écl. Électr. 49. pp. 342–344, Dec. 1, 1906.)—This paper describes developments of the system jointly patented by M. Leblanc and the French Westinghouse Co. [see Abstract No. 12 (1906)], and shows its application to a "dry" air-pump. F. J. R.

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

INDUSTRIAL ELECTRO-CHEMISTRY, GENERAL ELECTRICAL ENGINEERING, AND PROPERTIES AND TREATMENT OF MATERIALS.

17. *Decker Primary Battery.* F. B. Crocker. (Electrical World, 48. pp. 724–727, Oct. 13, 1906. Paper read before the Amer. Electrochem. Soc., Oct. 8, 1906. Centralblatt Accumulatoren, 7. pp. 280–281, Nov. 5, 1906. Abstract. Electrician, 58. pp. 296–297, Dec. 7, 1906. Rev. Électrique, 6. pp. 353–357, Dec. 30, 1906.)—The battery of F. A. Decker, of Philadelphia, overcomes many of the defects of primary batteries which the author has pointed out since 1888. It consists of zinc plates in sulphuric acid, and corrugated graphite plates in sodium bichromate and sulphuric acid. The porous cups for the zinc are made of slabs of earthenware with thickened edges and strengthened ribs, cemented by a clay, and afterwards ground down so that the walls are translucent. The internal resistance of a cell, with two zinc and three graphite electrodes, is 0·013 ohm. The containers are rectangular vessels of vulcanite, along the bottom of which run two conduits, one for each liquid; these conduits, which are filled by a pump or by forcing air into the tanks, communicate through openings and smaller conduits with the separate compartments and porous cups. The graphite connections are screws extending several inches into the thickened edge of the electrodes; the zinc connections are zinc plugs held down by screws; the outer connections are brass. A five-plate cell, weighing 17 lbs. complete, gave 24 amps. for 5¼ hours at 1·9 to 1·8 volts (218 watt-hours), and after being stirred, 24 amps. for 58 more min., a total of 247 amp.-hours. After refilling, which takes a few minutes, the battery would have given, with the same zincs, 22·5 watt-hours per lb. weight. The cell is thus considered superior to accumulators; it need not be recharged immediately and may be completely discharged. The primary cost of the cell is high; the space question is not touched upon. Lalande batteries would be heavier and could not bear the heavy discharges of the Decker battery, which is recommended for automobiles, train lighting, &c. H. B.

18. *Porous Zinc Electrode for Alkaline Accumulators.* (D.R.-P. 176,398. Centralblatt Accumulatoren, 6. p. 268, Oct. 20, 1906. Abstract.)—F. E. Polzeniuss and R. B. Goldschmidt point out that a paste of ZnO and $ZnCO_3$ does not give a durable electrode. But the electrolysis of hydrofluosilicate of zinc with zinc anodes deposits on thin, perforated zinc kathodes a well-adhering coating of porous, not spongy, zinc. These electrodes, which oxidise easily, are combined with positive electrodes of nickel or copper in alkali carbonate solution. The charge gives zinc and oxygen, the discharge ZnO and hydrogen. H. B.

19. *Borel and Dénéréaz Storage Battery.* (Schweiz. Elektrot. Zeit. 3. pp. 599–600, Dec. 8, 1906.)—The cells of this battery are of the columnar type, and are meant to be stood one upon another in the building up of a battery of cells. The containing vessel is an annular lead structure, on the inner walls of which the active material is held by means of the usual projections; this forms the negative electrode. The positive electrode consists of a hollow lead cylinder, coated on both sides with active material of the same

polarity. This cylinder is soldered (autogenously), with its walls vertical, on to a flat sheet of lead which, together with a ring of insulating material, forms the support for the next cell above. The positive cylinder dips into the containing vessel. A movable tube for filling and emptying is provided. Diagrams and an illustration showing a battery of 60 cells of 180 amp.-hours' capacity are given, the cells being stowed in six rows of ten cells each, and occupying very little space. [See also Abstracts Nos. 996, 997 (1904).]

L. H. W.

20. *Maintenance or Regeneration of Negative Plates.* (D.R.-P. 179,805. Centralblatt Accumulatoren, 7. p. 297, Dec. 5, 1906.)—The Akkumulatoren-Fabrik A.-G. propose, for the purpose of preventing the shrinking of the active spongy lead in negative plates, the addition from time to time, to the electrolyte, of solutions containing glue, albumen or starch, 5–10 gm. per litre of electrolyte; of rubber, sugar, or dextrin, 15–20 gm.; of phenol, 2–4 gm.; or of pyrogallol or oxalic acid, 5–10 gm. The mixing up of such substances with the paste, as previously suggested, is of little use, since they disappear after a time. The method is applicable to new plates or for regenerating old ones. L. H. W.

21. *Application of a specially Effective Active Material for Battery Plates.* (Brit. Pat. 52 of 1906. Centralblatt Accumulatoren, 7. p. 266, Oct. 20, 1906. Abstract.)—The patent of C. Jeantaud deals with the use of the hitherto unknown [so-called] allotropic modification of lead [see Abstract No. 785 (1905)]. This lead when exposed to the air oxidises very rapidly, and has a higher heat of combination than ordinary lead, which latter is looked upon as a condensation product of the new form. The new form retains its character in oxides and salts, and is said to take up nearly twice as much oxygen in electrolysis for the same number of amp.-hours, and hence has about twice the capacity. The method of preparation is here given for the first time [so that the existence or non-existence of the allotrope should be capable of being proved, see Abstract No. 785 (1905)]. A mixture of equal quantities of alkali plumbite and alkali plumbate on being electrolysed between two rolled-lead plates (25 cm. apart), at 15° and at a low current-density, shining silvery crystals of ordinary lead are obtained at the kathode. On the current-density reaching or exceeding a certain value (say 2 amps./dm.^{2}) dull grey crystals of the new modification appear. The limiting current-density depends upon the nature of the electrolyte, its concentration, the e.m.f. at the electrodes, and the temperature. Reference is directed in the patent to Nos. 2,945 of 1890 and 26,441 of 1897. L. H. W.

22. *Nitrocellulose Plate Separators and Envelopes for Batteries.* (Centralblatt Accumulatoren, 7. p. 275, Nov. 5, 1906.)—Nitrated cellulose is unsuitable for separators or envelopes for the plates of batteries in that the fibre swells and obstructs the circulation, and in the wet state it is too conducting. C. T. Dörr proposes the employment of gelatinised nitrocellulose (D.R.-P. 177,217). This is prepared by dissolving nitrocellulose in acetone, amyl acetate, acetic ether, &c., and spinning threads of suitable thickness from the solution; the threads are then, after freeing them from the solvent, worked up into a form of cloth. The fibres of this cloth are quite smooth, are not attacked by acids, and are good insulators in the wet state. For primary cells the cloth can be

used in place of the porous cell, whilst in accumulators it can be employed for enveloping the plate or as a support for the active material, in which case the paste is filled into a hollow envelope of the gelatinised fibrous cloth.

L. H. W.

23. *Nickel and Copper recovery from Thin Nickel-plated Sheets.* C. Richter. (Elektrochem. Zeitschr. 13. pp. 185–190, Dec., 1906.)—In the manufacture of cartridge cases, a large amount of scrap and cuttings are produced from the thin sheet iron which is employed after coating with copper, or with copper and then with nickel. The average composition of this scrap is 92·49 per cent. iron, 6·40 per cent. copper, and 1·11 per cent. nickel. The scrap cannot be used without preparation for iron-production on account of its high percentage of copper, and chemical or mechanical methods of separating the coating of copper and nickel from the iron beneath it, have not proved satisfactory. The author has worked out the details of an electrolytic recovery process, which is said to be an improvement upon the other methods that have received trial. The process consists of the following operations: (1) The scrap and cuttings are freed from grease and dirt by treatment in a revolving drum with caustic lime, soda, and sand; the drum and its contents being warmed during this operation. The scrap is then washed with water. (2) The scrap and cuttings are now fixed in suitable holders or frames, and hung in the electrolytic bath, which consists of a wooden tank coated internally with paraffin wax, and filled with dilute sulphuric acid containing 240 gm. H_2SO_4 per litre of solution. In this bath the scrap is made the anode, and lead sheets are used as kathodes, 4 anodes and 5 kathodes being employed for each bath. When a current at 1·2 volts is passed through the bath, the Ni passes into solution as nickel sulphate, while the greater part of the Cu separates as a loose powder on the kathodes and then falls to the bottom of the tank in the form of a mud or slime. The process is stopped when the iron surface of the scrap is entirely freed from its coating of Cu and Ni; and the iron can then be utilised directly in the Martin process, or for precipitating Cu in the wet copper-extraction process. (3) The copper slimes are removed periodically from the bottom of the bath, and then washed, dried, and worked up as refined copper. (4) The liquors from the bath containing Ni and Fe in the form of sulphates, with small amounts of Cu as an impurity, are first freed from this copper by electrolysis between insoluble electrodes, and are then evaporated until crystallisation commences. The double sulphate salt of iron and nickel which is obtained as crystals is then worked up for nickel by a chemical method. J. B. C. K.

24. *Preparation of Alkali Cyanides.* (D. R.-P. 176,080. Zeitschr. Elektrochem. 12. pp. 901–902, Dec. 14, 1906. Abstract.)—O. Schmidt points out that when magnesium or calcium nitride is heated with carbon and soda, the mass becomes incandescent, and sodium cyanide can afterwards be extracted by water; the air must be excluded. The reaction is—

$$Mg_3N_2 + Na_2CO_3 + C = 2NaCN + 3MgO.$$

One may also, without previous isolation of the nitride, work in a nitrogen atmosphere according to: $3Mg + 2N + Na_2CO_3 + C = 2NaCN + 3MgO$. Five parts of Mg_3N_2 of 78 per cent. are mixed with 4·1 parts of dry soda and 0·5 of calcined pine-soot, and heated in a hydrogen current over gas for half an hour or more. Or 3·6Mg, 5·3Na_2CO_3, and 2 pine-soot are heated in a nitrogen atmosphere at dark-red glow for several hours. H. B.

25. *Obtaining Alumina from Bauxite.* (D.R.-P. 175,416. Zeitschr. Elektrochem. 12. p. 901, Dec. 14, 1906. Abstract.)—When bauxite is lixiviated with caustic soda in the proper proportions of 1 molecule of Al_2O_3 to 1·7NaOH, the alumina yield is 97·6 per cent.; with other proportions the yield is much smaller. A caustic soda of 27 per cent. is recommended, and 10 kg. of bauxite are heated with the soda for two hours in an open boiler. Most of the alumina is precipitated; the rest falls out on addition of milk of lime. If the constituents of the bauxite should bind the soda, more soda has to be applied. The process is that of F. Curtius and Co. H. B.

26. *Reduction of Psilomelane (Barium Manganite) to Barium Carbide and Metallic Manganese.* (D.R.-P. 176,615. Zeitschr. Elektrochem. 12. p. 902, Dec. 14, 1906. Abstract.)—According to D.R.-P. No. 180,644, C. M. J. Limb heated the ore in an electric furnace with sufficient carbide to reduce all the constituents. But the formation of BaC_2 takes place at a high temperature at which some Mn is volatilised. The carbon percentage is therefore limited to the content in Mn, and the mixture is slowly heated in an electric furnace under additions of a flux, CaO, CaF_2, $BaCO_3$, $BaSO_4$, &c. The resulting Mn or Mn alloy is almost free of C; the slag is heated in another furnace with an excess of C and of some metal (Fe) to bind P, S, Si. An impure barium carbide is then obtained which yields impure acetylene and a lye from which $Ba(OH)_2$ can be crystallised. H. B.

27. *Manufacture of Silicides of Iron and other Metals.* (Electrochem. Ind., N.Y. 4. pp. 464–465, Nov., 1906.)—In F. J. Tone's process (U.S. Pat. 833,427) iron silicides are prepared by heating a mixture of iron and carborundum with Fe_2O_3 or SiO_2 in the electric furnace, the reactions being $Fe + 3SiC + Fe_2O_3 = (3Fe + 3Si) + 3CO$ and—

$$Fe + 2SiC + SiO_2 = (Fe + 3Si) + 2CO$$

respectively. Silicides of Cu, Al, Mn, and Ca may be obtained by analogous reactions. If only carborundum and the oxide of the metal, whose silicide is required, are employed, the relative proportions may be calculated such that the carbon liberated will be the exact amount necessary to reduce the oxide, *e.g.*, $Fe_2O_3 + 3SiC = (2Fe + 3Si) + 3CO$. The process is applicable to the production of double silicides of the metals and of silicon alloys. Thus a mixture of 200 parts carborundum, 87 parts manganese dioxide, and 102 parts alumina will yield an alloy containing 140 parts Si, 55 parts Mn, and 54 parts Al, the reaction being expressed by the equation—

$$5SiC + MnO_2 + Al_2O_3 = (5Si + Mn + 2Al) + 5CO.$$

W. H. Si.

28. *The Electric Furnace and its Application to the Metallurgy of Iron and Steel.* **R. S. Hutton.** (Engineering, 82. pp. 779–781, Dec. 7, 1906. Paper read before the Sheffield Soc. of Engineers and Metallurgists, Oct. 1, 1906. Mech. Eng. 18. pp. 925–928, Dec. 29, 1906. Abstract.)—The present conditions of electricity supply are far more favourable than they were in the days of the pioneers of electro-metallurgy, Siemens and Cowles. Water power can be supplied in Norway at 12s. and at Niagara at 83s. and less per electrical h.p.-year, and the deficiency of water power in Great Britain does not render electro-metallurgy impossible there. Water power is not available all the

year round, and the cost estimates for England are too often based upon supply stations whose load-factors hardly attain 80 per cent. Steam power can be obtained at 96s., or 0·25d. per B.Th.U., and Mond gas at 0·105d. In some cases the electric furnace offers no intrinsic advantage, apart from convenience and flexibility, and may not do more than lead to improvements of the fuel-heated furnaces. In ferro-alloys, however, some companies have achieved considerable success, notably the Cie Électrothermique Keller, Leleux, et Cie, at Livet; the Soc. Electro-Métallurgique Girod at Ugine, Courtepin, and Monbovon, which makes ferro-tungsten with high tungsten and low carbon percentage for tools, and another steel with less than 2·5 per cent. tungsten for springs; the Soc. Néo-Métallurgique of Rochefort-sur-Mayenne; the English Giffre Co. of St. Jeoire, in Savoy; and the Willson Aluminium Co., of Kanawha Falls, Virginia, which makes ferro-chromium; the American carbide works have also taken this industry up; reference is made to Steinhart's statistics. As regards iron ore reduction, the author refers to the Canadian Commission of Harbord, and Héroult's recent experiments at Sault Ste. Marie. The h.p.-year expenditure on 1,000 kg. of iron has in some cases been as low as 0·25, and the author criticises Hadfield's "theoretical value" 0·895 as far greater than the actual practice figure. Good steel is certainly made by the Kjellin and Héroult processes; Stassano and Keller should also be mentioned, and Girod has recently obtained promising results. The author counts twelve Kjellin furnaces in operation or under construction, two for maximum powers of 725 kw. (in Germany), and outputs of 120 tons per 24 hours; the firms of Krupp, Vickers, and Völklingen are interested in these furnaces. The new Héroult furnaces in Remscheid and Syracuse rely on steam power. Scrap and pig iron are melted in an arc furnace under a layer of basic slag, which is removed and renewed from time to time by a mixture of lime and ore. Owing to this thin layer of slag at very high temperature, its renewal, and the good circulation, Héroult's claim that he reduces P and S to below 0·01 per cent. and Si and C to almost negligible proportions, may prove acceptable. The decarburised and purified iron is afterwards mixed with "carburite" or some alloy or metal. As the Héroult furnace becomes charged with carbon monoxide, there is no danger of oxidation of the steel. H. B.

29. *Magnetic Separation of Zinc Ore.* (Engin. and Mining Journ. 82. p. 481, Sept. 15, 1906. Electrochem. Ind., N.Y. 4. p. 458, Nov., 1906.)—In the process adopted by the Joplin Separating Co., at Galena, Ill., the crushed and screened ore goes first to a ¼-in. impact screen, the undersize from which is separated into galena, pyrites, and blende on two Wilfley tables, the oversize going to a seven-compartment jig having 30 × 36-in. screens, on the first two cells of which a clean concentrate is made, and on the other five a mixed pyrites blende, the tailings flowing direct into the creek. The concentrates are drained and roasted for 2½ to 3 hours in such a manner as to burn off one atom of the sulphur of the pyrites, and the cooled ore is transferred to a belt elevator which delivers it to two trammels, each installed over a bin holding 80 tons, and one of which is fitted with both a ⅛-in. and a ¼-in. screen, while the other has only a ⅛-in. screen. The product from the ¼- and ⅛-in. screen is kept separate, and each size fed to a Cleveland-Knowles separator. The middlings product from the second magnets go to a 10 × 12-in. recrushing rolls, and then to a screen having 3-mm. holes, the oversize being returned to the rolls. The undersize passes to a third magnetic separator, the middlings from which are not treated further. Cutler-Hammer resistance

boxes are used to regulate the current, which on the first or roughing magnets is 2 amps., and on the finishing magnets 6·5 amps., the voltage being kept at 90. The average of the concentrates made last year gave for the ¼-in. size 60·49 per cent. Zn and 2·11 per cent. Fe, and for the ⅛-in. size 57·07 Zn, and 2·19 per cent. Fe. W. H. Si.

30. *New Thermo-electric Generators for large Currents.* A. **Heil.** (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1963–1964, Dec. 1, 1906. Paper read before the Elektrotechn. Verein, Karlsruhe, May 17, 1906. Elektrotechn. Zeitschr. 27. pp. 986–987; Discussion, pp. 987–988, Oct. 4, 1906.)—After dealing with the reasons why thermo-electric generators have hitherto proved unsuccessful the author describes his own improvements. The best method of soldering the parts forming an element was found to be to heat the nickel to a dark-red heat and to rub antimony on it. After this preparation the nickel can easily be welded on to an antimony alloy, the antimony here acting partly as its own soldering material. A sectional elevation and plan of one of the author's thermopiles is given, the elements being grouped round a central metallic cylinder formed of a secret non-oxidisable alloy; the function of the cylinder is to equalise the fluctuations in the heating power of the coal or of the burner employed. The elements are separated from the cylinder and from one another by mica. The author claims also to have found that the positive metal—the antimony alloy—can be made to give a higher voltage than ordinary substances of the same composition. This was discovered during measurements carried out to see if an increase of contact resistance existed at the warm end; but the contrary effect was observed, the part at the warm end showing about 30 per cent. less resistance than that at the cold end although of the same material. The cold end of the positive body is found to show a 30 per cent. higher p.d. to a heated constantan electrode than the warm end, when running, although previously both ends behaved alike. This property is made use of in the latest forms of the author's thermopiles, made by A. Schoeller, of Frankfort o/M. One of these, using 0·5 m.^{3} of gas per hour gives 2·5 amps. at 10 volts. The e.m.f. is 18–20 volts and the internal resistance 3·5 ohms. The resistance loss is thus 40–50 per cent. and the useful p.d. only 50 per cent. of the e.m.f., as in other thermopiles. The author advocates their employment for supplying current for ignition purposes, the pile being heated by the engine exhaust gases. L. H. W.

31. *Alloy as Substitute for Platinum.* (U.S. Pat. 824,618. Metallurgie, 3. p. 808, Dec. 8, 1906. Abstract.)—Deals with an alloy called pro-platinum. According to the inventor, C. H. Birmingham, this alloy possesses all the properties of platinum and can be substituted for that metal in electrical instruments. The alloy can be rolled into sheets and drawn into wire as easily as platinum itself, and is not attacked. Its colour is greyish-white, and it is made by taking 4·2 lbs. of nickel, 16·5 oz. silver, 0·5 oz. bismuth, and 58 oz. gold, or in per cent.: Ni, 72·0; Ag, 23·57; Bi, 3·72; Au, 0·71.

L. H. W.

32. *Cables, and Electric Phenomena at very high Voltages.* E. **Jona.** (Ind. Élect. 15. pp. 474–476, Oct. 25, 1906. Abstract of paper read before the Assoc. électrotechnique italienne. Écl. Électr. 49. pp. 891–892, Dec. 8, 1906. Electrician, 58. pp. 125–126, Nov. 9, 1906.)—At the time of the Congress of the *Association électrotechnique italienne* the author made experiments on high pressures at the stand of Pirelli and Co. in the Exhibition. A 150-kw.

transformer was employed, pressures of 160 and 320 kilovolts being easily obtained. Two types of cable were tested. In the first type the stranded copper conductor is enveloped directly in a lead sheath. Round this we have layers of various dielectrics, caoutchouc, paper, &c., and finally the lead sheath. The dielectric is thus graded in the manner first described by the author in 1898 and patented by Pirelli and Co. in March, 1900. At the Paris Exhibition in 1900 a cable graded in this manner was shown working at 25 kilovolts. The object of putting the lead sheath round the stranded conductors is to make the electric intensity in the first layer of dielectric more uniform [see Abstract No. 2924 (1904)]. The grading secures that the electric intensity throughout the dielectric is very approximately uniform. Portions of the cable 5 or 6 m. in length were tested for dielectric strength. It is necessary to prepare the ends of the lengths of cable very carefully before testing so as to avoid superficial discharges. The lead sheath was stripped from the ends to a distance of 1·5 m. Blocks of resinous matter were then moulded to and porcelain insulators slipped on the uncovered dielectric. In three tests on three different lengths the breakdown voltage was 208, 202, and 210 kilovolts. This shows that the dilectric strength of the cable is very approximately constant. The radii of the inner and outer lead sheaths is 9 and 24 mm. respectively. Hence the dielectric strength in volts per cm. is very high. Experiments were also made on portions of the type of cable used by Pirelli and Co. for transmitting 6,000 kilowatts by three-phase alternating current at 18,000 volts across the Lake of Garda from Ponale to Rovereto. This cable has a single core, the section of which is 75 mm.^{2}. The core is covered with lead and a layer of caoutchouc 5·5 mm. thick. Next there is a layer of guttapercha 1·2 mm. thick, and over this a jute wrapping. It is then armoured with 18 steel wires, each of which is 3 mm. in diam. In order to diminish the self-induction of the cable each steel wire is separately insulated. The resistance and the transverse reluctance of the armouring have thus been enormously increased. One of the terminals of the testing transformer was attached to the conductor, the other to the armouring. The pressure was then gradually increased to 100 kilovolts. At this pressure violent sparking took place between the armouring and the core but the cable was uninjured. Overhead wires were supported on four bell insulators made by the Company of Richard Ginori. They were of porcelain, 40 cm. high, and had a max. diam. of 32 cm. The overhead wires were 1·6 m. apart and had sections of 20, 40, 80, and 100 mm.^{2} respectively; the object being to show the effect of the curvature of the wire on the electric intensity produced at its surface. The experiments were made at night. At 50 kilovolts the corona round the 20 mm.^{2} wire was apparent, but the pressure had to be 100 kilovolts before any phenomena appeared round the 100 mm.^{2} wire. The pressure was gradually raised to 280 kilovolts. The hissing noise at this pressure was considerable and discharges in the shape of sparks, aigrettes, plumes, &c., appeared on the line and insulators. The electrostatic field was so intense that sparks could be obtained from any insulated conductor in the neighbourhood. Vacuum tubes also glowed when brought near the lines. At 290 kilovolts a spark from the line set fire to a post supporting an insulator, and ended the test. A. R.

33. *Real and Imaginary Power.* **P. Boucherot.** (Rev. Électrique, 6. pp. 289–292, Nov. 30, 1906.)—The author has several times previously insisted on the importance of considering that power consists of two components—the real power, VA cos ϕ, and the imaginary power, VA sin ϕ. He

states that once we are familiar with this device very many abstruse calculations in connection with alternating currents are enormously simplified. The errors introduced in solving problems by graphical methods are notoriously large, and the use of imaginary quantities is not to be recommended, as the ordinary engineer considers them mysterious. The author has shown that we can always add "real power" algebraically, and that apparent power is the square root of the sum of the squares of the real and imaginary power components. To illustrate the simplicity and power of his method he considers two examples. The first is the problem of a choking coil BC and a condenser CD in series with it and tuned to resonance. The condenser is then shunted by any kind of circuit CXD, and it is proved at once that if V be the p.d. between B and D, A the current in the circuit CXD, and L the inductance of the choking coil, then $V = \omega LA$. In the second example he shows how the equations giving the values of the currents and e.m.f.'s in two circuits having an inductive relation between them can be readily found.

A. R.

34. *Design of Electromagnets.* **F. Emde.** (Elektrotechnik u. Maschinenbau, 24. pp. 945–951, Nov. 25; 973–977, Dec. 2; and pp. 998–999, Dec. 9, 1906.)—In this elaborate and highly mathematical series of papers the author deals with the theory and design of various types of electromagnets. The method of treatment differs from those hitherto customary, in that the author adopts, as the basis of his calculation of the forces exerted on the movable core, equations expressing the change in the energy of the magnetic field for a given displacement of core or given change of exciting current. The theory of alternating-current electromagnets receives special attention. The technical part of the paper deals with solenoid and rotating electromagnets, and a number of formulæ for these are established. In the case of rotary magnets, whose design is such that the magnetic flux passes from the pole-pieces into the armature in a substantially radial direction, it is shown that the torque exerted on the armature is proportional to the difference of the reciprocals of the air-gap lengths under the polar edges.

A. H.

35. *Effect of Iron in distorting Current Waves.* (Amer. Inst. Elect. Engin., Proc. 25. pp. 780–807, Nov., and pp. 874–876, Dec., 1906. Discussion. Electrician, 58. pp. 573–576, Jan. 25, 1907. [For Bedell and Tuttle's paper, see Abstract No. 1917A (1906)].)—**C. P. Steinmetz** drew attention to some practical aspects of wave distortion. In the case of a sine wave of impressed p.d. across the terminals of Y-connected transformers, the p.d. wave between each terminal and the neutral point of the system contains a third harmonic which may be of considerable amplitude. If the secondaries of the transformers are connected to a long transmission line, and if the neutral is earthed, the third harmonics are in phase with each other with respect to the circuit formed by the inductance of the transformer windings and the capacity to earth of the transmission lines. Such an arrangement may, under unfavourable conditions, give rise to dangerous surges in the system. But in any case the periodic rise and fall of the mean potential of the transmission line relatively to earth will cause electrostatic disturbances in neighbouring telephone lines. Similar considerations show that it is not advisable to earth the neutral points of paralleled Y-connected generators unless their wave-shapes are absolutely identical; if earthing is adopted, a suitable resistance should be introduced to limit the currents from the neutral points to a safe value.

A. H.

36. *Self-inductance of Straight Conductors and Rectangular Coils.* **J. K. Sumec.** (Elektrotechn. Zeitschr. 27. pp. 1175–1179, Dec. 20, 1906.)—The author establishes formulæ for the magnetic force at a given point due to a straight conductor of finite length conveying unit current, and for the magnetic flux through a rectangular area whose plane passes through the axis of the conductor. Maxwell's "geometric mean distance" of an area from itself is next introduced, and the self-inductance of a rectangular loop formed by a conductor of rectangular cross-section is calculated. The somewhat complicated expression so obtained is compared with the various approximate formulæ suggested by different writers. The problem of the self- and mutual inductance of several indefinitely long parallel straight conductors (such as those forming a transmission line) is next dealt with, and some criticisms are advanced on the discussion which took place on this subject some little time ago [Abstract No. 1586 (1905)]. A. H.

37. *Electric* v. *Hydraulic Elevators.* **S. M. Bushnell.** (Cassier, 30. pp. 251–255, July, 1906.)—The author has collected data regarding energy consumption of drum type electric elevators in five office buildings in Chicago. The kw.-hours per car-mile vary from 2·19 to 3·45 (average 2·91). This figure is compared with that given by T. E. Brown (3·19 kw.-hours). As regards hydraulic elevators operated by electric pumps, the author gives 6 kw.-hours as the average (T. E. Brown, 5·9); or supplied by a steam pump the water h.p.-hours average 6·37. The actual net lifting efficiency under ordinary working conditions (not full load of passengers always) is held to be about 20 per cent. and 10 per cent. for the electric and the hydraulic elevator respectively. L. H. W.

REFERENCES.

38. *Recent Developments in the Gin Electric Furnace.* **G. Gin.** (Faraday Soc., Trans. 2. pp. 44–48; Discussion, pp. 48–52, Aug., 1906.)—[See Abstracts Nos. 50, 714, and 813 (1906).]

39. *Electric Smelting of Steel.* **E. Haanel.** (Amer. Chem. Soc., Journ. 28. pp. 935–964, Aug., 1906. Écl. Électr. 49. pp. 49–57, Oct. 13, 1906. Also Faraday Soc., Trans. 2. pp. 120–136; Discussion, pp. 136–141, Dec., 1906.)—Describes the experiments witnessed by the Canadian Commission [see Abstract No. 59 (1905)]. W. W. H. G.

40. *The Theory of the Power-factor.* **A. F. Ganz.** (Frank. Inst., Journ. 162. pp. 429–448, Dec., 1906.)—The theory of the power-factor is given, particular attention being given to the case when the time-lag is zero and the power-factor is less than unity. As illustrations, oscillograph records for an alternating-current arc and for a Cooper-Hewitt mercury vapour rectifier are given and analysed. The theory is also extended to the case of pulsating continuous currents, and curves for the e.m.f. and current in a rectified current circuit of a single-phase mercury vapour rectifier charging a battery of storage cells are given. A. R.

41. *Design of Electromagnet Coils.* **R. Edler.** (Elektrotechnik u. Maschinenbau, 24. pp. 1013–1020, Dec. 16; 1038–1043, Dec. 23; and pp. 1058–1062, Dec. 30, 1906.)—The author deals with the design of coils for distant control switches, relay magnets, &c., deducing a large number of formulæ and calculating various tables intended to facilitate the calculation of the winding for given conditions. Special attention is given to the question of temperature rise. A. H.

42. *Continuous Wire-drawing Machine.* (Engineer, 102. p. 352, Oct. 5, 1906.)—Illustrated description of machine designed by W. Carter and E. Hodgson for overcoming the slipping on the drums which usually takes place owing to the elongation of the wire in drawing.

GENERATORS, MOTORS, AND TRANSFORMERS.

43. *Design Coefficients for Electrical Machinery.* **H. M. Hobart** and **A. G. Ellis.** (Elect. Rev. 59. pp. 726–727, Nov. 2; 785–788, Nov. 9; 845–847, Nov. 23; and pp. 884–887, Nov. 30, 1906. Écl. Électr. 49. pp. 425–428, Dec. 15, and pp. 498–499, Dec. 29, 1906.)—The authors give curves relating to the output coefficient ξ for various classes of electrical machinery, ξ being defined by the equation $\xi = w/(d^2\lambda g r)$, where w = rated output, in watts; d = air-gap diam., in cm.; λg = gross core-length, in cm.; r = r.p.m. It is pointed out that although the output coefficient forms an extremely convenient starting-point for a design, its value cannot be regarded as furnishing a reliable criterion of the excellence of any particular design, as sometimes the best design is not that having the highest ξ. In one case, for example, the authors find that an increase of 47 per cent. in ξ resulted in an increase of only 8 per cent. in the total works cost. Owing to steady improvements in design, the value of ξ has materially increased within the last few years. The following table relates to continuous-current machines:—

Armature diam., cm. ...	50	100	150	200	250	300	350
ξ	0·0028	0·003	0·0033	0·0035	0·0036	0·00368	0·00372

Dealing next with the weight of continuous-current machines, and defining the "specific weight," ρ, as ρ = (net weight in kg.)/($d^2\lambda g$), the authors give the following set of corresponding values of ρ and $d^2\lambda g$:—

$d^2\lambda g$ ...	5×10^4	10^5	$1·5\times10^5$	2×10^5	$2·5\times10^5$	3×10^5	$3·5\times10^5$	4×10^5	5×10^5	10^6
ρ	0·027	0·025	0·0236	0·0226	0·0216	0·0208	0·020	0·0195	0·019	0·0165

$d^2\lambda g$ ...	2×10^6	5×10^6	10^7	$1·5\times10^7$
ρ	0·0145	0·0115	0·009	0·008

The relation connecting the total works cost, in £ per metric ton, with total weight, is given by the following table (the metric ton = 1,000 kg. = 2,200 lbs.):—

Total weight of machine, in metric tons...	0·25	0·5	1·0	1·5	2·0	5	10	20	50	100
Works cost, £ per metric ton	90	77	68	53	47	46	45·5	45	43	40

Induction motors are next dealt with, and the following table refers to the relation connecting ξ with rotor diam., the voltage of the motors being 500:—

Rotor diam., in cm............	10	20	30	40	50	60	70	80
ξ	0·0005	0·00086	0·00115	0·00136	0·00155	0·0017	0·0018	0·00185

The next two tables connect ρ and $d^2\lambda g$, and cost and net weight of induction motors:—

$d^2\lambda g$	2×10^4	4×10^4	6×10^4	8×10^4	10^5	$1·5\times10^5$	2×10^5	3×10^5	$3·5\times10^5$
ρ	0·0215	0·018	0·016	0·0148	0·0139	0·0123	0·0112	0·0098	0·0092

Net weight of motor, in metric tons	0·1	0·2	0·3	0·5	1·0	2·0
Works cost, £ per metric ton	63·5	61	60	57·5	56	52·5

Alternators are next dealt with, some data for which are embodied in the following tables:—

Values of ξ for Low and Moderately Low Speed Polyphase Alternators.

Rated output in kilovolt-amps.	500	1,000	2,000	3,000	4,000	5,000
ξ	0·0013	3·0015	0·00177	0·00197	0·0021	0·0022

Table connecting $d^2\lambda g$ *and* ρ.

$d^2\lambda g$.....,	4×10^5	6×10^5	8×10^5	10^7	$1{\cdot}5\times10^7$	2×10^7	$2{\cdot}5\times10^7$	3×10^7	4×10^7
ρ	0·01	0·008	0·0075	$6{\cdot}5\times10^{-3}$	$5{\cdot}4\times10^{-3}$	$4{\cdot}8\times10^{-3}$	$4{\cdot}25\times10^{-3}$	$3{\cdot}8\times10^{-3}$	$3{\cdot}25\times10^{-3}$

A. H.

44. *Methods of obtaining Good Commutation.* **A. Mauduit.** (Rev. Électrique, 6. pp. 292–295, Nov. 30, 1906.)—The author first explains the phenomena connected with commutation. He lays stress on Arnold's formula, namely, that ρT must be greater than L for good commutation, where ρ gives the contact resistance between a line of brushes and the commutator, T the period of the commutation in seconds, and L the inductance of a coil between two commutator bars. This may also be expressed by saying that the reactance pressure must be less than the loss of p.d. due to the contact resistance. Obtaining good commutation by making the reactance pressure small is not possible either in the case of shunt-wound variable-speed motors or of high-speed machines—for instance, the dynamos coupled to steam turbines. In these cases auxiliary poles are used. In this case we simplify the construction of the armature, but the construction of the field is more expensive and there is the loss in the windings of the auxiliary poles. Multiple dynamos with a parallel winding have as many auxiliary as principal poles, but with a series winding and two lines of brushes only two auxiliary poles are necessary. A. R.

45. *New Design of Commutating Pole Dynamo.* **V. A. Fynn.** (Electrician, 58. pp. 288–289, Nov. 30, 1906. Écl. Électr. 50. pp. 82–84, Jan. 5, 1907.)—The main objects of the new design described by the author are the reduction in the amount of copper required for producing the commutating flux and prevention of distortion of the main field by the armature. Excessive field distortion increases the voltage between certain commutator segments, and

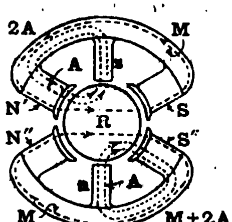


FIG. 1.

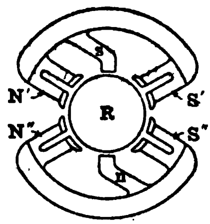


FIG. 2.

is liable to cause flashing over. The new design is illustrated in the figures, which refer to a two-pole machine. Each main pole consists of two independent units separated by a wide air-gap. This throttles the armature cross-flux, and so prevents distortion of the main field. Further, the arrangement provides a path of low reluctance for the commutating flux, and along

this path there is no armature magnetomotive force to be overcome as in the ordinary designs. Hence the number of series turns required to produce the commutating flux need only be small. The series turns may be placed on one of the main pole units, as shown in Fig. 1. An alternative arrangement is to use no series turns, but to connect the auxiliary pole to the yoke, as shown in Fig. 2. A. H.

46. *Pulsations in Magnetic Flux due to Rotation of Toothed Cores.* **O. S. Bragstad.** (Elektrotechnik u. Maschinenbau, 24. pp. 1055–1057, Dec. 30, 1906.)—In machines whose stator and rotor cores are both toothed, a periodic pulsation of the flux through each tooth of either core is brought about by the rotation of the rotor. If m = r.p.m.; t_s = number of teeth in stator; t_r = number of teeth in rotor; and if f_s, f_r stand respectively for the frequencies of flux pulsation in stator and rotor teeth, then

$$f_s = \frac{m}{60} \cdot t_r \text{ and } f_r = \frac{m}{60} \cdot t_s.$$

Such pulsations in the tooth flux, which are of much higher frequency than the pulsations of the main flux, increase the core losses, mainly by reason of the increased eddy-current loss in the teeth. The author has investigated experimentally the amplitude of the flux pulsation by means of search coils surrounding a rotor and a stator tooth, current being supplied to the stator when using the rotor search coil, and *vice versâ*. The e.m.f., E, induced in the search coil consists of two components, one being the low-frequency component E_l due to alternations of the main field, the other the high-frequency or pulsation component E_p. The total e.m.f. is given by

$$E = \sqrt{E_l^2 + E_p^2}.$$

The curve connecting E with the speed enables us to separate E_l and E_p, since E_p vanishes at zero speed, and E_l at synchronous speed. In a certain induction motor the author found the amplitude of the rotor pulsation to amount to 11·6 per cent., and that of the stator pulsation to 4·5 per cent., of the amplitude of the main flux pulsation. The above percentages were found to be approximately constant at frequencies from 30 to 40 ∿, and to be unaffected by variations of the total flux. From the amplitudes of the pulsations the author calculated the additional eddy-current loss, and found this to be in fair agreement with values obtained experimentally by the retardation method. A. H.

47. *Constant-current Dynamo.* (West. Electn. 39. pp. 466–467, Dec. 8, 1906.)—The dynamo described is the invention of M. Milch, of Schenectady, who has assigned his patent to the General Electric Co., (U.S. Pat. 835,868). Considering a two-pole machine, the arrangement is as follows: The field frame is a four-pole one in shape, and the various field coils surround different quadrants of the yoke. Let 1, I, 2, II, 3, III, 4, IV denote, in succession, the poles and yoke quadrants, the Arabic numerals referring to poles, and the Roman ones to yoke quadrants. Across the terminals of the machine are connected the shunt coils S_1 and S_2, arranged around I and III. These tend to make 4 and 1 of one polarity, and 2 and 3 of the other. The main brushes are placed half-way between 1 and 2, and 3 and 4. The armature current tends to produce a cross-magnetisation, so as to make 1 and 2 of one polarity,

and 3 and 4 of the other. This cross-magnetising effect is not only completely wiped out, but a cross-magnetising effect in the opposite direction produced, by a couple of coils M_1, M_2, connected in series with the armature and placed around II and IV. The cross-field so produced induces an e.m.f. in the armature which, by means of an auxiliary pair of brushes, arranged at 90° relatively to the main brushes, produces a current in four coils connected in series with each other and with the auxiliary brushes, one coil surrounding each quadrant of the yoke. The connections of this last set of coils are such that while one pair (that around II and IV) assists the cross-magnetisation due to M_1 and M_2, the other (that around I and III) opposes the coils S_1 and S_2, and thereby weakens the main field. The current is by this means maintained approximately constant over a wide range of variation in the speed or the resistance of the external circuit. A. H.

48. *Calculation of E.M.F. induced in Polyphase or Single-phase Winding.* **H. Görges.** (Elektrotechn. Zeitschr. 28. pp. 1–6, Jan. 3, 1907.)—The author develops a method based on the determination of the magnetic flux through each individual tooth. This flux is obtained by considering the ampere-turns producing it, and the determination is greatly simplified by the aid of a special vector diagram devised by the author. The flux through each tooth being known, that through any one coil embracing a given number of teeth also becomes known, and on the assumption that the time-rate of change of flux obeys the simple harmonic law, the e.m.f. in each section of the winding, and hence also the total e.m.f., are easily calculated. Formulæ are deduced for various space wave-shapes of the magnetic flux. A. H.

49. *Measurement of Fluctuations in Angular Velocity.* (Elect. Rev. 59. p. 891, Nov. 30, 1906.)—The following method, which is intended for the measurement of the periodic phase-displacements taking place between two paralleled alternators, is due to G. Huldschiner. One alternator carries on its shaft a metal disc into which is let a short piece of insulating material at a certain part of the circumference. Two brushes, connected in series with a secondary battery and the primary of an induction coil, press against the circumference of the disc, so that normally the primary of the coil is closed. It is, however, opened once in each revolution as the brushes pass on to the strip of insulating material which forms part of the circumference of the disc. The second machine carries on its shaft a disc of insulating material in which is cut a curved slot, so shaped that the increase in the length of radius intercepted by the slot is proportional to the angular displacement of the radius. On each side of the disc is arranged a strip of brass placed radially, the two strips facing each other and being connected to the secondary of the induction coil. In front of one of the strips (*i.e.*, between it and the disc), a strip of paper wide enough to cover the slot is drawn along by hand. As the spark passes through the slot at its point of intersection with the brass strips forming the sparking terminals, it pierces the paper. If there is absolutely no hunting, the record will consist of a straight line; but if hunting is taking place, the relative positions of slot and sparking strips will alter, and the spark will travel alternately inwards and outwards along a radius, thereby producing a sinuous record from which the extent of the phase-swinging may be determined. A. H.

50. *Armature Reaction in Polyphase Alternators.* **L. A. Herdt.** (Elect. Rev., N.Y. 49. pp. 889–893, Dec. 1, 1906.)—The writer first carries through

a diagrammatical investigation of the armature reaction in polyphase alternators, basing his procedure on the principles laid down by Blondel in his 1899 paper entitled "The Empirical Theory of Alternators" [Ind. Élect. 8. p. 481, (1899)]. He then applies the method to the estimation of the flux under various conditions of amount and of phase-displacement of the external load. These estimates are then, for a given machine, plotted as curves, and are shown to compare well with the experimentally obtained results. The article closes by describing methods of measuring the demagnetising and cross-magnetising effects of armature reaction, and the armature leakage flux. It is stated that the method has been applied to a number of alternators, and has been found to give very accurate results. H. M. H.

51. *Armature Reaction in Single-phase Alternators.* **J. K. Sumec.** (Elektrotechnik u. Maschinenbau, 24. pp. 989–998, Dec. 9, 1906. Écl. Électr. 50. pp. 62–64, Jan. 12, and pp. 95–98, Jan. 19, 1907.)—This is an entirely theoretical paper, and refers to an ideal type of alternator—one in which both stator and rotor windings are distributed around the gap periphery according to the simple sine law. Magnetic leakage and resistances of the windings are assumed to be negligible. The stator being excited with a continuous current, and the rotor being short-circuited, the latter is driven at a speed corresponding to a frequency n. The alternating rotor field due to the current induced in the rotor by the impressed stator field may be resolved into two equal rotating fields of half the amplitude, rotating in opposite directions, so that one of them is stationary with respect to the stator, while the other revolves relatively to it at twice the speed of the rotor, thereby inducing in the stator winding an alternating current of frequency $2n$. This current gives rise to a field which may be resolved into two equal and oppositely-rotating fields of half the amplitude. One of these—that rotating in the same direction as the rotor—induces in the latter a current of frequency n, while the other, which rotates in an opposite direction, induces a current of frequency $3n$. The field due to the latter may again be replaced by two equal and oppositely-rotating fields, which induce currents in the stator having frequencies $2n$ and $4n$; and so on. From the above it is evident that there will be currents of frequencies n, $3n$, $5n$, &c., in the rotor, and currents of frequencies 0, $2n$, $4n$, &c., in the stator, and with negligible magnetic leakage and resistances of windings, the currents would be indefinitely large. An extremely small amount of leakage is, however, sufficient to reduce the currents enormously (with only 5 per cent. of total (stator and rotor) leakage, the stator current is only 1·55, and the rotor current 1·47, times the exciting current). The effect of an entirely inductive load is next considered, and then the behaviour of the short-circuited machine when a choking coil is introduced into the exciting circuit. The last section deals with the effect of damping circuits arranged on the stator. A. H.

52. *Voltage Drop in Alternators.* **H. M. Hobart** and **F. Punga.** (Elekt. Bahnen, 4. pp. 649–652, Dec. 4; and pp. 677–680, Dec. 14, 1906. Écl. Électr. 50. pp. 59–62, Jan. 12; 92–95, Jan. 19; and pp. 185–187, Jan. 26, 1907.)—After giving an account of the method devised by them in 1904 [Abstract No. 1060 (1904)], the authors briefly review and criticise the numerous methods proposed by other investigators, and express the opinion that in the case of machines having salient poles it is impossible to construct a vector diagram which correctly represents the physical facts of the case. Where extreme accuracy is required, Arnold and La Cour's method appears to be the most

serviceable one. For ordinary purposes, the authors regard their own method as preferable, as it has the advantages of being straightforward and elementary in treatment, so as to be easily followed by a student having only a slight acquaintance with the subject. A. H.

53. *Single-phase Repulsion Motor of Brown, Boveri and Co.* K. Schnetzler. (Schweiz. Elektrot. Zeit. 3. pp. 594–596, Dec. 1; 604–607, Dec. 8; and pp. 613–615, Dec. 15, 1906. Écl. Électr. 50. pp. 65–66, Jan. 12, and pp. 98–100, Jan. 19, 1907.)—The form of repulsion motor patented by Déri (Swiss Pat. 28,964) is now being manufactured for a variety of uses by Brown, Boveri and Co. The main features of this motor have already been described [Abstract No. 601 (1905)]. Instead of a single set of short-circuited brushes, as in the ordinary type of repulsion motor, it is provided with two brush sets, one of which, F, consists of brushes permanently fixed at the mid-points of the polar arcs, while the other, M, is made movable [see Fig. of Abstract No. 601 (1905)]. Each brush of the set F is connected by a short-circuiting conductor to a neighbouring brush of the set M, and brushes of like polarity may or may not be joined together. Speed regulation is obtained by shifting the brushes M. If a is the angle, in electrical degrees, between F and M, it is found by experiment that the maximum starting torque per unit of current is obtained when a lies between 150° and 160°. The following table gives the experimentally determined relations connecting the h.p., speed and angle a of a 10-h.p., 6-pole, 50-∿ motor of this type :—

Speed, r.p.m.	600.	800.	1,000.	1,200.	1,400.
h.p. $a = 95°$	5·5	5·2	4·4	3·3	2·4
h.p. $a = 115°$	10·2	8·4	6·6	5·1	3·6
h.p. $a = 135°$	20·2	14·4	10·3	7.7	5·3
h.p. $a = 145°$	24	18·5	13·7	10·4	8·4

The efficiency and power-factor for various outputs at a constant speed of 900 r.p.m. were found to be as follows :—

H.P.	2.	4.	6.	8.	10.	12.	14.	16.
Efficiency, per cent ...	64	75	81	84	85	85	84	83
Power-factor	0·49	0·64	0·74	0·80	0·84	0·87	0·88	0·90

The limits of speed regulation obtainable by shifting the brushes M may be considerably extended if the stator winding is subdivided and connected to a suitable switch by means of which the number of turns may be varied. Another method consists in connecting the short-circuiting cables of opposite polarity through an adjustable resistance. A powerful braking torque may be obtained by disconnecting each M brush from its F brush, and connecting the M brushes in pairs. Various other methods of obtaining a braking effect are described. As regards constructional details, the stator consists of stampings having equally spaced slots, the slots in the middle of a pole being left unwound. The stator winding is characterised by great simplicity, as there is no crossing of coil-ends, and as a result even the smallest sizes may be built for high voltages. The rotor consists of an ordinary drum-wound armature *without any resistances* between the winding and the commutator.

From 2 h.p. upwards the rotor winding is a bar winding. The rotor voltage seldom exceeds 100 volts when running light, and drops to 10 volts or even less as the motor is loaded up. There is thus great security against insulation troubles. The displacement of the brushes M is effected either by a simple lever attached to the brush ring, or by means of toothed, chain, or rope gearing from any desired point. In the larger sizes, worm gearing is employed to move the brush ring supporting the M brushes. If the motor is required to be reversible, each brush set is mounted on a movable ring, so that either may be used as the F or M set. A. H.

54. *Crane Motors and Controllers.* **C. W. Hill.** (Inst. Elect. Engin., Journ. 36. pp. 290–318; Discussion, pp. 314–321, April, 1906. Elect. Rev. 58. pp. 588–590; Discussion, pp. 590–591, April 13, 1906. Abstract. Elektrotechn. Zeitschr. 27. pp. 1121–1122, Nov. 29, 1906.)—A practical paper on the rating of crane motors. The author says that some of the more common methods of specifying the size of the crane motor are as follows: (1) The h.p. required to lift or move the load, plus gearing losses, is taken as the b.h.p. of the motor. The motor is specified to be of this power, with a load-factor of 20 per cent., 25 per cent. &c., with continuous runs not exceeding, say, 5 min., and temperature-rise of 75° F.; (2) the h.p. required to lift or move the load, exclusive of gearing losses, is taken as the b.h.p. of the motor. The motor is specified to be of this power and to be capable of exerting double power for a few minutes; (3) the h.p. required to lift or move the load, plus gearing losses, is taken as the b.h.p. It is specified to maintain this power on a continuous run of 1 hour with a rise of 75° F. and to maintain half this power for 4 hours with the same rise of temperature; (4) the h.p. required to lift or move the load, plus gearing losses, is taken as the b.h.p. It is specified to maintain this power on a continuous run of ¼, ½, or 1 hour as the case may be, with a rise of temperature of 75° F. Numerous tables illustrate these different styles of rating and the whole subject is treated with many practical examples. W. J. C.

55. *Variable-speed Induction Motor.* (Electrical World, 48. p. 1101, Dec. 8, 1906.)—M. Latour has recently patented the following arrangement. The motor is provided with a squirrel-cage rotor, and the Gramme-wound stator is arranged to produce either six or four poles. Any intermediate speed between the two extreme limits is obtainable by means of the following method of control. At starting there are six complete poles; two of these are then omitted, and the remaining four are gradually separated, so that the polar arcs lengthen until they cover the entire circumference, when the speed is at its maximum (U.S. Pat. 835,444). A. H.

56. *Prevention of Sparking in Repulsion Motors.* (West. Electn. 39. pp. 456–457, Dec. 8, 1906.)—C. A. Ablett, of Schenectady, has patented the following invention, which he has assigned to the General Electric Co. (U.S. Pat. 834,098). The type of motor is one in which each rotor coil is short-circuited independently when suitably placed with respect to the stator poles There are two sets of rotor coils, arranged like the two circuits of a two-phase machine. The brushes are of sufficient width to cover two commutator segments. The stator has salient polar projections, the length of pole-arc being less than the pole-pitch. Each of the rotor coils is of approximately the same width as a polar projection. Hence a coil will in certain positions be

quite clear of the polar projections, the magnetic flux through it and its self-inductance being reduced to their minimum values. It is when occupying this position that the circuit of the coil is opened. On the other hand, since it is desirable to increase the self-inductance of each coil while it is under cover of a pole-piece, a sliding ring is provided carrying]-shaped masses of magnetic material which may be made to embrace the projecting coil-ends. These masses are at a sufficient distance from the stator poles not to be appreciably affected by the stator field. The self-inductance of a rotor coil at the instant when it is open-circuited is still further reduced by placing damping-bridges between the stator polar projections. A. H.

57. *Prevention of Sparking in Single-phase Commutator Motors.* (Electrical World, 48. pp. 1187–1188, Dec. 22, 1906.)—In a recent patent, S. S. Seyfert proposes the following arrangement. The armature is provided with two independent windings, connected to alternate bars of the commutator. Each brush set is represented by a double row of brushes, one row being placed slightly in advance of the other, and any single brush having a width not exceeding that of a single commutator segment. Under these conditions, no coil of either winding is ever short-circuited by a single brush. The two rows of each set are connected through an impedance coil, the middle point of which is joined to the main cable. In order to prevent sparking due to the interruption of the local current around the impedance coil, this coil is shunted by a suitable non-inductive resistance. A. H.

58. *Series* v. *Repulsion Single-phase Motors.* **R. Richter.** (Elektrotechn. Zeitschr. 28. pp. 21–24, Jan. 3, 1907.)—The author replies in detail to Eichberg's criticisms [Abstract No. 1188 (1906)]. While admitting that there is better utilisation of the winding-space in motors having no resistance connectors, he points out that the use of such connectors presents advantages in other directions. In a motor having no resistance connectors the transformer e.m.f. in the short-circuited coil must be extremely small if the motor is to run sparklessly. This involves the use of an abnormally large and costly commutator, which increases the brush frictional loss; the latter is, on account of the high peripheral velocity of a commutator of large diameter, a very serious matter. Assuming the transformer e.m.f. of a compensated repulsion motor without resistance connectors to amount to 6 volts under normal running conditions, and the potential drop over the brush contacts to be 2·5 volts, at starting the transformer e.m.f. would have to be reduced to, say, 3 volts in order to prevent the brushes from being overloaded by the short-circuit current. Hence in order to obtain full-load torque at starting, the field having been reduced to half its full-load value, twice the armature current will be required, corresponding to an armature copper loss 4 times that at full load. If the starting torque required were $2\frac{1}{2}$ times the full-load torque, the armature current would have to be 5 times, and the copper losses 25 times, those at full load. From the above the advantages of resistance connectors will be evident. Referring to some published data of a Winter-Eichberg motor, the author states that the points corresponding to maximum efficiency and $\cos\phi = 1$ lie far apart, that at maximum efficiency the $\cos\phi$ is hardly better than in a common series-wound motor, while at $\cos\phi = 1$ the efficiency has dropped 10 per cent. below its maximum value. As regards Eichberg's reference to Richter's devices as being complicated, the latter states that, on the contrary, the stator winding is characterised by its extreme

simplicity, and that although it is divided into a number of sections to serve different purposes, outwardly it does not differ from an ordinary polyphase armature winding. A. H.

59. *Traction Permutators.* (Ind. Élect. 15. pp. 544–550, Dec. 10, 1906. Electrician, 58. pp. 580–581, Jan. 18, 1907.)—The earliest design of the Rougé-Faget permutator [Abstracts Nos. 1662 (1905), 88 and 604 (1906)] was intended for substation use. The new type now described, which formed one of the exhibits at Milan, is intended for use on an electric railway motor car, the motors being of the standard continuous-current type. The permutator exhibited transformed 820-volt three-phase into 500-volt continuous current, but machines of this type may also be built for single-phase current. The shaft of the machine is vertical, so that it occupies a small floor space. The general arrangement of the cores, of which there are four, resembles that of two induction motors placed vertically above each other. Let S_1, R_1, and S_2, R_2, denote the outer and inner cores (corresponding to the stator and rotor parts of an ordinary induction motor) of the upper and lower members respectively. The alternating current or primary winding is arranged partly in the upper parts of the slots of S_1, and partly in the slots of R_2. The secondary or continuous-current winding consists of vertical conductors whose upper portions occupy the lower parts of the slots of S_1, and whose lower portions fill the slots of S_2. This winding is at the top connected to a hollow commutator. The core R_1 is the only *rotating* core, and carries the winding of the brush motor. The brushes revolve outside the commutator. The core R_2 is arranged to be movable, and by rotating it into various positions the continuous-current voltage may be varied from zero to its maximum. In the zero-voltage position the inductive effects on the secondary winding due to S_1 and R_2 oppose and completely neutralise each other, while in the full-voltage position of R_2 they are arithmetically added. In intermediate positions the addition is a vectorial one, and depends on the angle between the magnetic fields of S_1 and R_2. Since the phase of the resultant equivalent field varies as R_2 is rotated, it is obvious that provision must be made in the brush motor for causing the brushes to advance or recede so as to keep pace with the changes in the phase of the neutral line due to the angular displacement of R_2. For this purpose R_2 is provided with a double winding; a fine-wire winding connected across the brushes, and a thick-wire winding connected on one side to one of the brush slip-rings, and on the other to a supplementary or third slip-ring, between which and the remaining brush slip-ring is introduced a rheostat. It is shown that the required shifting of the brushes so as to keep pace with the shift of the resultant field is obtained by designing the rheostat so that the resistance of the thick-wire circuit varies as the cotangent of the angle through which the phase of the resultant field advances. This "cotangent rheostat" is suitably geared with the hand-wheel by means of which R_2 is moved. A polyphase permutator of the above construction allows of perfect regulation of the continuous-current voltage impressed on the motors, without the use of any resistances in the continuous-current circuit, or changes in the primary voltage; and it may be used on either polyphase or single-phase circuits of frequencies lying between 15 and 50. A. H.

REFERENCE.

60. *Circle Diagram for Single-phase Motors.* **U. R. Andrei.** (Elettricista, Rome, 5. pp. 278-281, Oct. 15, 1906.)—A new circle diagram due to J. Bethenod.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

61. *Power Transmission by Underground Cables.* **A. Still.** (Elect. Engin. 38. pp. 690–692, Nov. 16, 1906.)—Methods are described for predetermining the losses in the 3-core cables used for the transmission of electric power. The following data for a 3-core cable made by Glover and Co. for use on a 10-kilovolt circuit are quoted. The section of each core is 0·1 sq. in. The capacity between one core and the remaining cores in parallel with the sheath is 0·216 mfd. per mile, and the capacity between two cores in parallel and the remaining core and sheath in parallel is 0·36 mfd. per mile. [It follows that the coefficient of electrostatic self-induction of each core is 0·216 mfd. per mile, and the coefficient of mutual induction between each core is —0·036 mfd. per mile.] Examples explaining the use of vector diagrams in connection with cable calculations are worked out, and some empirical formulæ for use in practical work are given. A. R.

62. *Use of Iron Masts on High-voltage Transmission Lines.* **L. Kallir.** (Elektrotechnik u. Maschinenbau, 24. pp. 837–842, Oct. 21; and pp. 861–868, Oct. 28, 1906. Paper read before the "öster. Vereinig. der Elektrizitätswerke" in Linz, June 12, 1906. Elect. Engin. 38. pp. 698–700, Nov. 16, 1906. Écl. Électr. 49. pp. 352–354, Dec. 1, et seq., 1906.)—The author discusses the relative advantages and disadvantages of wood and iron poles on high-voltage transmission lines. Owing to the very large size of the insulators and distance apart of the wires, a wooden pole construction presents serious difficulties when the voltage reaches a value of 60,000. Even at lower voltages, wood poles become impracticable along sharp curves or with long spans, such as river or valley crossings, &c. On long lines which must be capable of supplying important consumers with absolute security and without the risk of any disturbances, a difficulty arises on account of the comparatively short life (8 to 15 years) of wood poles, and consequent frequency of renewals; the maintenance costs of the line if constructed with wood poles then become very heavy. Further, with wood poles there is not the same degree of security as with iron ones in cases of fire or lightning, and a wood pole may appear sound though greatly decayed, especially where the moisture of the ground is liable to attack it. If iron masts are used, the length of span may be increased, the number of insulators reduced, each insulator made heavier, and the chances of breakdown materially reduced. Iron masts should be carefully earthed—especially when set in concrete—in order to prevent any dangerous p.d.'s between them and the earth if an insulator should develop a fault. This earthing is best carried out by means of an earthing conductor which connects all the masts, and is earthed at intervals, and by fixing it above the level of the line wires it may be made to act as a lightning protector. A serious disadvantage of iron masts is their high initial cost, which goes a long way towards wiping out the saving as regards maintenance. The design of an iron pole line is considered in detail by the author; the relative advantages of copper, aluminium, and steel as conductors are discussed, and the allowance to be made for wind-pressure

and possible accumulations of ice or snow on the line wires. An illustrated description is then given of typical forms of masts and towers used in connection with recent transmission lines. A. H.

63. *Smoothing out of P.D. Waves by means of Condensers.* **C. F. Guilbert.** (Écl. Électr. 49. pp. 441–451, Dec. 22, 1906.)—A network, the capacity of which is inappreciable, is first considered and a condenser of capacity K, is supposed placed between the bus-bars. We may replace the network by an equivalent non-inductive resistance, R, and a choking coil, L, connected in parallel. If the equivalent inductance of the alternators be l, and R be infinite, there will be resonance of the harmonic of order p when—

$$p^2\omega^2 K\,[lL/(l+L)] = 1.$$

If therefore K is greater than $(l+L)/\omega^2 lL$, resonance of the higher harmonics will be impossible. In order, however, that the amplitude of the pth harmonic when the condenser is used be less than its amplitude without the condenser, K must be greater than $2(l+L)/p^2\omega^2 lL$, that is, twice the value of the capacity which would produce resonance of the pth harmonic. If we choose $K = (L+l)/\omega^2 lL$, so that there is resonance of the first harmonic, and consequently resonance of the higher harmonics is impossible, the ratio of the amplitudes of the pth harmonic with and without the condenser will equal $1/(p^2-1)$, and hence the p.d. wave will be approximately sine-shaped. When R is finite it is proved that the condition for resonance of the harmonic of order p in the current wave flowing in the condenser circuit is—

$$K = (l+L)/p^2\omega^2 lL + (1/R^2)[lL/(l+L)],$$

and this value of K increases with the load. In order to avoid the risk of the harmonic of order p being in resonance either in the p.d. or current wave, it is necessary and sufficient that K be greater than—

$$(l+L)/\omega^2 lL + (1/R^2)\,[lL/(l+L)].$$

The greater the value of the self-inductance of the alternators and the line the greater the effect of a condenser in smoothing out the waves. If the line and the alternators were non-inductive, the condenser would have no effect at all. In conclusion the author examines the influence of a uniformly distributed capacity on the amplitude of the harmonics in a network. He finds that the only case in which this capacity screens from resonance and where the harmonics of higher orders are reduced is when concentric cables of negligible self-inductance are used. A. R.

64. *Long-distance Transmission Lines.* **A. Blondel.** (Écl. Électr. 49. pp. 121–130, Oct. 27; 161–166, Nov. 3; 241–249, Nov. 17, and pp. 321–338, Dec. 1, 1906.)—A complete practical method of calculating the currents and voltages at any points in polyphase transmission lines is proved theoretically and illustrated by several practical examples. [See Abstracts Nos. 847, 993 (1906).] The labour entailed in evaluating the complicated formulæ previously given by Heaviside, Kennelly, and others is pointed out. This has probably prevented the practical engineer from studying them and thus acquiring the knowledge essential in the successful design of long-distance transmission lines. The author only uses imaginary quantities in one place in this paper, and then merely to show how a certain solution can be arrived

at more rapidly by their use. He takes into account capacity and inductance by means of real quantities, and gives graphical constructions which greatly simplify the problem. He first gives a straightforward solution of the differential equations for the general case. These equations can be verified easily. He then shows how the pressure and current at each point can each be represented by two vectors. The calculations for an actual line are given. A single-phase transmission line to transmit 20 kw., and 1,000 km. long is considered. The pressure at the distributing station is 80 kilovolts and the resistance of each main is 0·0682 ohm per km. A simple line diagram is drawn which shows the pressures at various points along the line. It is thus found that if the current at the distributing station be 300 amps., and if it have a lag of 36° 50′, so that $\cos \phi = 0{\cdot}80$, then, at the power station the supply voltage is 165·6 kilovolts, and the power $165{\cdot}6 \times 272 \times 0{\cdot}655 = 29{,}500$ kw., and at the distributing station $80 \times 300 \times 0{\cdot}80 = 19{,}200$ kw. The simple cases of a line on open and short circuit are next considered, and the formulæ are expressed in terms of hyperbolic functions. A second solution of the problem is next arrived at by the novel and simple method of superposing the open-circuit and short-circuit systems of working, a suitable voltage being chosen in the latter case and the vectors being turned through a certain angle depending on the power-factor of the load. This is proved both graphically and by analysis. The complete diagram is given for a projected 3-phase transmission line 1,000 km. long. The pressure at the distributing station is to be 60 kilovolts star (104 mesh). The section of each conductor of the 3-wire spiralled overhead system to be 88 mm.²; their distance apart, 2·5 m.; and their mean height from the ground, 6 m. The kilometric constants of each main are $r = 0{\cdot}215$ ohm, $l = 1{\cdot}268$ millihenry, and $k = 0{\cdot}00718$ mfd. The following are some of the results obtained :—

	Cos ϕ = Power-factor at Distributing Station.	
	Cos $\phi = 1$.	Cos $\phi = 0{\cdot}8$.
Pressure at power-house	77·8 kilovolts	81·6 kilovolts
Current	115 amps.	78 amps.
Watt current	107·5 „	77·5 „
Power-factor	0·93	0·99
Power generated	25,090 kw.	18,972 kw.
Power at distributing station	18,000 „	14,400 „
η	0·72	0·76

The efficiency of the transmission with the power-factor at the distributing station 0·8 is greater than with unity power-factor, but if we increase the current in the former case to 125, so that the same power is transmitted in the two cases the efficiencies become practically the same. The author gives clear and full instructions how to make all the necessary calculations. By the aid of Hoüel's "Recueil de formules et de tables numériques" (Gauthier-Villars, 1901), the calculations can be made very quickly and easily. Finally, many useful approximate formulæ are given which will be sufficient in some practical cases. A. R.

65. *Measurement of Current-density of Stray Currents.* **F. Haber** and **K. Liese.** (Zeitschr. Elektrochem. 12. pp. 829–852, Nov. 16, 1906. From the

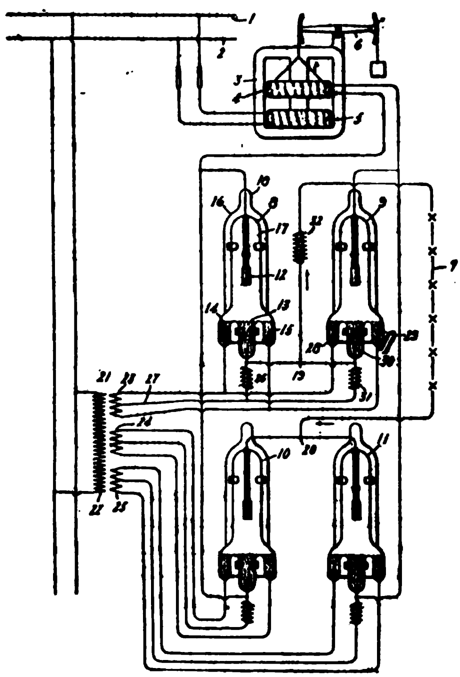
Chem.-techn. Inst. d. Hochschule, Karlsruhe.)—In continuation of the work done by Haber and Goldschmidt [Abstract No. 681A (1906)], the authors of the present paper have carried out a series of investigations on the current-density of the stray currents traversing the soil in the neighbourhood of an electric tramway line. Two forms of apparatus were devised for this purpose. In one, two copper plates, each 11 cm. square and 0·5 mm. thick, were used. These were insulated from each other by mica, and were supported in a frame of ebonite, which in its turn fitted into a larger frame of wood. This frame could be buried in the position required, and by means of two insulated wires connected to the copper plates, a suitable galvanometer or milliammeter could be introduced between them. The second form of apparatus consisted of two silver plates, each 11 cm. square and 0·8 mm. thick, laid against each other without any insulation, and similarly supported. By allowing the frame to remain in the soil for a sufficient length of time, and determining the corresponding charge of weight of each plate, the value of the current-density could be deduced. Preliminary experiments were carried out with the view of testing the reliability of the apparatus. In the case of the copper-plate apparatus, a thin layer of an acidulated paste of copper sulphate was held against the plates and was separated from the soil by a sheet of parchment paper soaked in a 10 per cent. solution of Glauber's salt. In the case of the silver plates, a paste of silver acetate and water was used. With the electrodes arranged in this manner, it was found that the polarisation effect was negligible. The deposit of silver obtained was found to adhere firmly to the plate and to separate readily from the paste. Between the limits of 0·05–1 amp./sq. dm., the arrangement is capable of yielding extremely accurate results, and fair accuracy is obtainable at somewhat higher current-densities. Below 0·01 milliamp./sq. dm. the apparatus is useless. The authors employed the above apparatus to investigate the stray current density in various streets along the route of the Karlsruhe electric tramway line, and were by means of it able to locate a certain danger area, where subsequent investigation showed that the pipes were actually undergoing rapid corrosion. A. H.

66. *Use of Buffer Battery in Connection with Alternating-current Supply System.* (Engineering, 82. p. 577, Oct. 26, 1906.)—The arrangement described has been patented by Siemens Brothers and Co. (Brit. Pat. 8,677 of 1906). Between the slip-rings of the rotary converter and the alternating-current supply mains is introduced an alternating-current booster, by means of which the main converter voltage is varied as required. The action of the booster is controlled automatically by a solenoid introduced into one of the alternating-current supply mains. The solenoid actuates the arm of a rheostat connected in series with the booster field, the exciting current for which is derived from the buffer battery. The adjustments are such that corresponding to normal load on the network the buffer battery simply floats across the booster terminals; a decrease of load causes the solenoid to weaken the booster field, thereby lowering the booster e.m.f. and raising the p.d. across the converter slip-rings, thus causing the converter to charge the battery. The opposite effect takes place when the load increases above the normal.

A. H.

67. *Mercury Vapour Rectifiers for Series System of Distribution.* (West. Electn. 39. p. 415, Nov. 24, 1906.)—The system described is the invention of R. Fleming, of Lynn, Mass., and has been assigned by him to the General

Electric Co. (U.S. Pat. 836,854). It is shown in the Fig., where 4 and 5 are the secondary and primary coils of a constant-current transformer, the four rectifiers shown being connected across the secondary coil. The first pair of rectifiers, 8 and 9, have their anodes across the secondary coil, while the second pair, 10 and 11, have their kathodes similarly connected. The load 7 of series lamps is connected between the junction 19 of the kathodes of the first pair of rectifiers and the junction 20 of the anodes of the second pair, a choking



coil 32 being introduced for the purpose of reducing the current fluctuations. In order to keep the rectifiers "excited," *i.e.*, maintain the necessary amount of mercury vapour in them, an exciting transformer, 21–22, is employed, whose secondaries are connected, as shown, to the rectifier mercury reservoirs, with the interposition of choking coils (26 and 31). The rectifiers are started by tilting them. During one half-wave of current 8 and 11 are active, while during the next half-wave 9 and 10 supply current to the load. A. H.

68. *Breakdowns caused by Electrostatic Effects.* **R. P. Jackson.** (Elect. Journ. 3. pp. 646–649, Nov., 1906. Elect. Engin. 38. p. 761, Nov. 30, 1906.)—The author mentions several cases of breakdowns due to electrostatic disturbances having no connection with lightning. A typical one is that of two 6,600-volt generators delivering power to a transmission line through delta-connected transformers, by means of which the voltage is raised to 66,000. It was found that when an earth occurred on one of the transmission wires, the insulation of the generators broke down. The following simple explanation is advanced by the author. The primary and secondary windings of the transformer may be regarded as the two plates of a condenser, and the

armature windings and frame of the generator as the plates of a second condenser connected in series with the first. Under normal conditions the mean potential of the high-voltage transformer windings is zero. But the occurrence of an earth on one of the line wires immediately raises the mean potential of the high-voltage windings to a considerable value, and as a consequence the mean potential of the primary windings and that of the generator armature also rise. This rise may be sufficient to puncture the insulation of the armature. As a remedy, the author suggests earthing the neutral point of the generator through a suitable resistance. A. H.

69. *Electric Driving of Winding Engines.* **F. Niethammer.** (Zeitschr. Vereines Deutsch. Ing. 50. p. 1921, Nov. 24, 1906.)—The arrangement of the Ilgner motor-generator set which the author has found most advantageous is as follows: The three-phase induction motor is arranged at one end of the shaft, and is elastically coupled to the continuous-current generator, which in its turn is elastically coupled to the flywheel. The exciter for the dynamo is driven by a small induction motor, and is connected in parallel with a secondary battery, partly in order to utilise the buffer action of the battery, partly to secure greater reliability. The exciter set is preferably arranged with its shaft parallel to the main shaft carrying the motor-generator set, so that it may be driven off this shaft by belt if necessary. The author gives some account of his experiences with ball bearings for the flywheel. Rapid wear was found to take place, necessitating frequent renewals. On the other hand, the bearings proved highly economical as regards lubrication and attendance. For flywheels over 10 tons in weight, ordinary bearings with forced lubrication and water-cooling devices would appear to be alone admissible; roller bearings have given good results in practice, but are too expensive. [See also Abstract No. 1335 (1906).] A. H.

70. *Steam* v. *Electric Winding in Main Shafts.* **W. C. Mountain.** (Inst. Elect. Engin., Journ. 36. pp. 499–505; Discussion, pp. 518–584, July, 1906. Abstract of paper read before Manchester Section, and rediscussed in London. Electrician, 57. pp. 54–55, April 27, 1906.)—The author gives tables of costs (actual and estimated) of winding with steam winding engines, and compares the figures obtained with those for electric winding at the Grand Hornu mine. A similar paper by the same author, read before the Inst. of Mining Engineers (Electrician, 57. pp. 364–365, June 22, 1906) should be referred to. **G. Hooghwinkel.** (Ibid. pp. 506–518; Discussion, pp. 518–584, July, 1906. Abstract of paper read before the Newcastle Section, and rediscussed in London.)—Hooghwinkel considers that the pure three-phase system used at the Grand Hornu mine is not a fair example of modern electric winding practice. The original papers and the discussion, which also relates to Sparks' paper [see next Abstract], should be referred to for the figures given, as these are widely different in the two papers, in many cases are based upon different conditions, and are also criticised as well as supplemented by further information and figures given by the different speakers. L. H. W.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

71. *Electrical Winding Plant at the Aberdare Collieries.* **C. P. Sparks.** (Inst. Elect. Engin., Journ. 36. pp. 477–498; Discussion, pp. 518–584, July, 1906. Electrician, 56. pp. 932–935, March 23; 962–966, March 30; Discus-

sions, pp. 999–1002, April 6, and pp. 1045–1047, April 13, 1906).—The generating plant and winding equipment are very fully described. The system adopted is 3,000 volts 3-phase, 50 ∿, some direct current motors being driven off a motor-generator. Details are given of the motors employed and curves relating to current required for haulage. The cost per unit delivered to the transmission lines, with an output of 4½ million units per annum, load-factor of 37 per cent., using unwashed small coal at 4s. 2d. per ton (cal. value 13,000 B.Th.U.) works out at 0·18d. for works costs + 0·185d. interest and depreciation, a total of 0·365d. [The discussion relates also to the papers dealt with in the preceding Abstract.] L. H. W.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

72. *Overhead Equipment of Tramways.* **R. N. Tweedy** and **H. Dudgeon.** (Inst. Elect. Engin., Journ. 37. pp. 161–191; Discussion, pp. 191–225, Sept., 1906. Paper read before Birmingham Section and rediscussed in London. Tram. Rly. World, 19. pp. 329–335, April 5; 566–568; Discussion, pp. 568–570, June 7, 1906. Elect. Rev., N.Y. 48. pp. 417–420, March 17, 1906.)—Regarding the danger to pedestrians from overhead equipment, this is considered more apparent than real. The numerous and expensive safety guards run up the cost of the installation without conferring the expected amount of safety. Thus while the capital cost of tramways in Great Britain runs between the wide limits of £10,000 and £24,000 per mile of single track, the cost of overhead equipment may be taken as varying between £700 and £2,000 per route-mile. The authors are persuaded that in most cases tramway poles are too heavy, and they have also something to say with regard to lateral strain, and bedding and ventilating of the poles. The pole bases come in for some strong criticism, and the authors calculate that if this useless ornamentation were done away with, there would be a saving per route-mile of about £45. The pole collars also run up the cost per average route-mile some £30, for the reason that poles are too heavy; span wires tend in that direction also. Instead of bronze for hangers, insulator castings, &c., malleable iron might be used, providing it is well galvanised before use. A saving of about 60 per cent. might thus be effected in the cost of these articles. Regarding the trolley wire, the authors, after long observation, have come to the following conclusions: (1) That the depreciation due to rolling friction is almost negligible. (2) That sliding friction may be reduced to the same negligible quantity by attention to alignment and the universal use of swivel trolley heads of the freest type. (3) That arcing is the most serious trouble of all, and must be discounted by the use of modified trolley-wire section and a supplementary trolley wheel. (4) That the effect of an impure atmosphere needs further elucidation. (5) That the method of suspension does not affect the wear. (6) That the effects of (*a*) height of wire and (*b*) pressure of trolley wheel require careful examination. The whole paper is an earnest attempt to show how capital expenditure may be curtailed. The discussion which followed was of a favourable and very lengthy character. W. J. C.

73. *Electric Traction on Swiss Railways.* **W. Wyssling.** (Schweiz. Elektrot. Zeit. 3. pp. 523–526, Oct. 27, and pp. 541–545, Nov. 3, 1906.

[1] Non-electrical Automobiles are described in the Section dealing with Steam and Gas Engines.

Communication of the Schweiz. Studienkommission f. elektrischer Bahnbetrieb. Rev. Électrique, 6. pp. 268–270, Nov. 15, 1906. Street Rly. Journ. 28. p. 950, Nov. 10, 1906.)—The Commission appointed to consider the application of electric traction to all the Swiss railways has first examined the data as to power and energy requirements with a view to securing in advance the necessary water rights. In view of the numerous international connections of the Swiss railways, it was considered advisable to base the calculations on arrangements of trains similar to those now in use with steam service. The formulæ of Clark and Barbier for train resistance were compared with the results obtained at the Zossen experiments, and an examination of the actual speeds of various classes of trains on a representative division of the State railways showed that the following figures could be taken for the mean traction coefficients: *Fast trains*, 5·0 to 6·8; *Ordinary passenger trains*, 4·5 to 5; *Goods trains*, 3 to 3.2—all expressed in kg. per ton. *Starting.*—It is found that except on gradients of 2 per cent. and over, the effect of gravity, whether for imparting kinetic energy at starting or for absorbing it on stopping, is not available under practical conditions. For the present estimates, therefore, the whole kinetic energy represented by the starting of trains according to timetable has been worked out with an addition of 80 per cent. for goods and ordinary passenger trains, and 110 per cent. for express trains to cover speed variations and stops due to signals, permanent way repairs, and other contingencies. *Train Weights.*—An examination of the extensive data available showed that, while the passenger traffic is at its highest in August, the goods traffic reaches a maximum in October, though with less difference from the mean than in the case of the passenger traffic. The maximum weights of trains were used to determine the necessary weight of electric locomotive, according to the gradients occurring on the various sections, taking an adhesion coefficient of 1/7. The above data were applied to a detailed calculation of the energy required with the following results for one day:—

	Train-km.	Ton-km.	Energy in H.P.-hours measured on Wheels.				
			Rolling Friction and Gradients.	Recoverable from Gradients.	Starting.	Total.	Per Ton-km.
State Railways:—							
Division I.	0,978	6,023,400	160,265	(23,260)	59,725	219,990	0·0365
Division II.......	21,252	6,337,300	181,980	(47,374)	57,170	239,150	0·0376
Division III. ...	27,121	7,627,600	190,570	(21,500)	87,615	278,185	0·0377
Division IV. ...	12,190	3,355,500	85,870	(10,985)	38,920	124,790	0·0372
Total	81,541	23,343,800	618,685	(108,119)	243,430	862,115	0·0370
Gotthard Railway	12,830	4,550,400	158,180	(57,044)	17,475	175,655	0·0386
Other lines	19,390	2,142,370	95,830	(36,439)	19,270	115,100	0·0538
Totals.........	113,761	30,036,570	872,695	(201,602)	280,175	1,152,870	0·0384
Shunting	—	—	—	—	—	45,190	—

There would thus be 1,200,000 h.p.-hours required on the wheels, or with an over-all efficiency of 40 per cent. 3,000,000 h.p.-hours on the turbine shafts. *Load-factor.*—A detailed calculation of the load-factors of various sections showed in most cases a load-factor of 8 per cent. to 14 per cent., in many cases only 5 per cent. to 7 per cent., and in some as low as 3 per cent. On

the other hand, the Gotthard line has a load-factor as high as 80 per cent. In view of the fact that the sections having the heaviest traffic are also those with the best load-factor, it is concluded that for estimating the total generating plant required, a load-factor of 20 per cent. may be taken. This would mean a max. load of 500,000–600,000 h.p., and in view of the great fluctuations on various days and at different seasons, such water-power sites are to be preferred as offer the greatest facilities for storage. A. E. L.

74. *Johnson-Lundell Regenerative Control System of Electric Traction.* **E. H. Johnson.** (Electrician, 58. pp. 886–888; Discussion, p. 888, Dec. 14, 1906. Abstract of paper read before the Manchester Association of Engineers, Nov. 24, 1906. Mech. Eng. 18. pp. 797–800, Dec. 8, and pp. 853–856, Dec. 15, 1906.)—The motors carry two field spool windings. One of these is exclusively for series excitation; the coils of the other may be connected all in series for shunt excitation when the motors are sending back current into the line, or they may be connected in parallel to reinforce the regular series windings when the motors are propelling the car. Nine controller points are used, and intermediate combinations of these two sets of windings are employed at a number of these controller positions. For each of the controller positions there is a set of motor connections, and a set of regenerating connections. The change for any controller position to the regenerative connection corresponding to that position is effected by a field changer which is a circuit controller, made to operate automatically through the agency of an electromagnet, of solenoid form, and a retractile spring or gravity. Its function is to effect the conversion of the motor characteristic from series to compound, and *vice versâ*. It is controlled by the driver through the medium of the thumb switch placed in the handle of the main or platform controller, and may be considered the key to the system. By this double function of part of the exciting windings (either as shunt or series), a given weight of, and space devoted to field copper, permits a motor of given capacity to have improved characteristics as regards both its regenerative and its motor function. Each motor armature has two windings and two commutators, and consequently three series-parallel combinations, namely: (1) Four commutators in series; (2) two in series and two in parallel; and (3) all four in series. These are obtained with only two motors. The mechanical power brake used on the system consists of the following parts: The usual wheel and track shoes with their accompanying system of leverages, a specially constructed spiral band the purpose of which is to frictionally grip the axle or a shaft driven thereby and thus exert a pull on the brake levers; an electromagnetic solenoid carrying a weighted core the duty of which is to impose a drag on the free end of the spiral and thus bring the brake into action, the function of the solenoid, of course, being to pick it up and hold it when the brakes are not required. Contacts for controlling the solenoid are placed in both the platform- and the automatic-controllers, and in special emergency switches placed within ready reach of both the car driver and the conductor. Regeneration being the product of motion, necessarily ceases at some point short of final rest, hence there is needed a supplemental power brake which will accumulate a breaking force and maintain it after the car has come to rest. A device has therefore been introduced which utilises the energy of the moving car and applies it to the ordinary wheel and track shoes through the medium of a friction spiral surrounding the car axle or an auxiliary shaft driven thereby; this friction device is kept normally out of action by means of a solenoid controlled by contacts, placed in the main

controller at the point where regeneration ceases; hence the driver has but to continue the controller movement through the regenerating cycle on to this mechanical braking-point in order to bring his car to rest and hold it there. When the controller is again moved to start the car, the solenoid is energised and releases the frictional spiral, thus leaving the car free to respond to the spiral effort. Provision is also made for bringing this brake into action in conjunction with regenerative braking, so as to effect an emergency stop by uniting the braking force of the two. Further use is made of its potential characteristic by providing that it be automatically brought into action in the event of any failure of the electric current, as, for instance, through the loss of trolley contact or other circuit disruption or the failure from any cause of the main supply current. In such event the solenoid loses its energising force and the friction spiral becomes operative. This device provides an additional safety factor and a valuable one, since its action is inevitable and instantaneous in the event of the car being deprived of its motor control. Diagrams of connections for the nine controller positions are given in the paper. The following are the advantages claimed for the system: 1. Substantial energy saving, varying anywhere from 20 per cent. to 50 per cent. according to the conditions existing. 2. A reduction in capital investment in generating plant and distributing system, practically in the direct ratio of the energy saving. 3. The introduction of new and valuable factors of safety, inclusive of the simplification of the motor-man's duties. 4. A material saving in the net upkeep cost of permanent way, rolling stock, and generating plant. As an offset to these advantages it is claimed that there is but a slight increase in the complications of car equipments and but a slight increase in these equipment costs. An appendix gives results of some comparative tests of regenerative and non-regenerative cars at Norwich over distances of from 1 to 8 miles, showing a saving varying from 15 to 64 per cent. of power consumption in favour of the regenerative system, although the new car was about 1¼ tons heavier than the old car. A. G. E.

75. *Steel Rails.* **R. Job.** (Street Rly. Journ. 28. pp. 1012–1014, Nov. 24, 1906. Abstract of paper read before the New York Railway Club, Nov. 16, 1906. Eng. News, 56. pp. 557–558, Nov. 29, 1906.)—Discusses the causes of faultiness in modern rails, old rails being said to be better because, being of lighter section, the metal was more thoroughly worked, and finishing temperatures were lower. Photomicrographs of structure, and sections of fractures of rails are reproduced. Annealing modern rails to refine the structure is favourably regarded. [See also Abstract No. 1288 (1905).] F. R.

76. *Interurban Track Construction.* **C. de Burlet.** (Street Rly. Journ. 28. pp. 433–434, Sept. 22, 1906. Houille Blanche, 5. pp. 252–255, Nov., 1906. Paper read before the Milan Convention of the Internat. Street and Interurban Rly. Assoc.)—The Report is confined to a discussion of the proper length of rail, the use of welded joints, the maintenance of joints, and methods for preventing the loosening of bolts. Reports from various companies show that many varying rail-lengths are made use of, one company, the Paris Eastern, using rails 78 ft. 9 in. as compared with others of 19 ft. 8 in., the advantages being that they can be more easily laid, the number of joints is reduced, and the riding is more easy, though there is the inconvenience in handling. Some particulars on welded joints have been collected by the author, and it would appear that the companies using them are satisfied and consider that they add to the life of the track. The conclusions of

the writer are: 1. There is a tendency to increase the length of rails. 2. The experience with welded joints is not so positive as to warrant a definite conclusion. 3. Staggered joints are favoured on tangents, and opposite joints in curves of short radius. 4. No one system of preventing the loosening of the bolts is so superior to the others as to warrant its exclusive endorsement. C. E. A.

77. *Track Maintenance for Modern Conditions.* (Eng. News, 56. pp. 545–546, with Discussion, Nov. 22, 1906. Abstract of Report of Committee at the Annual Convention of the Roadmasters and Maintenance of Way Assoc., Nov. 13 and 14, 1906.)—A return to the old wide-base rail was recommended—5 in. high and 6 in. wide. Permanent road-beds should be 20 to 22 ft. wide for single and 34 to 35 ft. for double track on high banks or in cuttings. Tile drains should be made of at least 4-in. tile, 2 ft. below top of ballast, and covered with 1 ft. of cinders. Ballast should be of such sizes as will pass 1¼ to 2-in. sieves, but not ¾ in. Sleepers 7 × 9 in. × 8 ft. 6 in., 20 in. centres, are recommended, or 8 in. wide, 18 in. centres; at joints, 16 or 18 in. centres. Easement curves should be used on all curves exceeding 2°, for speeds not exceeding 30 m.p.h.; on all exceeding 1°, for speeds up to 60 m.p.h.; on all exceeding 60 min., for higher speeds. The super-elevation should run out with the easement; 100 ft. chord per degree is suited for ordinary practice, 150 ft. for very high speed, and as low as 25 for special cases. Papers on "Construction and Maintenance of Track in Tunnels," and "Tie Plates" were read and discussed. F. R.

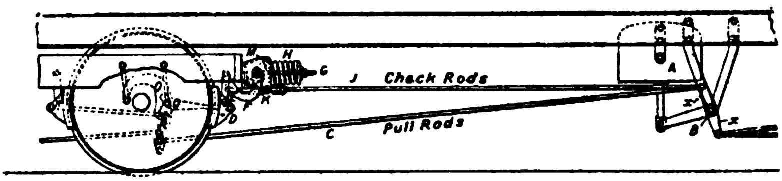
78. *Tramway Track Work.* **R. C. Bullough.** (Tram. Rly. World, 20. pp. 859–861; Discussion, pp. 861–863, Oct. 4, 1906. Elect. Engin. 38. pp. 443–445, Sept. 28, 1906. Electrician, 57. pp. 936–937; Discussion, p. 938, Sept. 28, 1906. Paper read before the Municipal Trams. Assoc., Sept. 20, 1906.)—In this paper important matters concerning present-day tramway track work are discussed in a concise manner. *Concrete.*—This is one of the most important parts of tramway construction. Soft earth should be removed and concrete filling used. Slow-setting cement should be used where possible. No cinders or brickbats, only broken stone and sharp sand. A perfectly solid foundation must be insured. The concrete bed must be first formed throughout and the rails laid upon it. *Rails.*—In the opinion of the writer the chemical analysis of rails for straight and curved track should differ, the former being of the hardest material possible, and the curves of softer, to admit of bending and to prevent undue wear on wheel flanges. He also recommends that all sharp curves should be laid with an ordinary T-rail, and a separate guard might be attached to the paving, thus enabling it to be renewed without disturbing much paving and without taking up the rails. Or the separate guard might be fixed to the web of the T-rail with filling-in pieces between the web and the guard, the whole being bolted together, the space, in both cases, between the rail and the guard being run with cement. *Points and Crossings.*—The practice of long leads and easy curves, now generally adopted, is satisfactory. The idea of manganese insert plates for crossings is a very costly thing, the plate being made so hard that the rails at each end of it are worn down first and the wear and tear on flanges becomes excessive. The author recommends a plate of mild steel or cast iron. Points are often wholly made of manganese steel, and this, too, in the writer's opinion is wrong, as entailing an excessive strain on wheel flanges and tyres. Manganese steel cannot be drilled or tapped, therefore no necessary

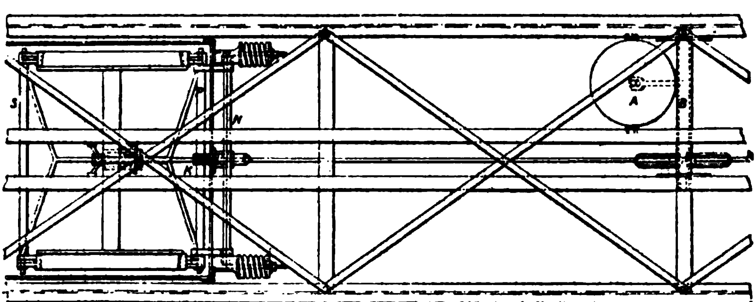
alteration can be made, and as scrap it is worthless. The curved switch is satisfactory if not of manganese. Cast steel box-points with wrought steel tongues and renewable plates of mild steel are the proper points to adopt. *Tie Bars.*—Very important; the slightest lateral movement of the rails causing irregular gauge tends to do considerable damage to the rolling stock, in addition to causing the cars to oscillate. *Fishplates.*—These should take no vertical strain at all. *Joints.*—The strength of a tramway track is represented by the joint; it is important, therefore, that it becomes as solid as any other part of the rail. The author has succeeded in perfecting an adjustable "rail-joint support," which is briefly described, and is the exact opposite to the so-called "anchor-joint." Welded joints are touched upon, but the chief difficulty with regard to them is that which arises when it is required to take out a rail. *Paving.*—Sett paving of some description is the best. *Creeping Rails.*—These in the writer's experience are extremely rare. He considers they were first noticed after the invention of the first anchor-joint. *Corrugations.*—The trouble evidently originates at the rolling mill. C. E. A.

79. *Ballast.* **C. H. Clark.** (Street Rly. Journ. 28. pp. 700–708, Oct. 20, 1906. Paper read at the Columbus Convention of the Amer. Street and Interurban Rly. Engin. Assoc., Oct., 1906.)—The author does not confine himself in this paper to the material used directly under the ties. The use of ballast must be governed by the material upon which it is to rest. The sub-foundation must first be thoroughly settled. In sandy streets the trench should be puddled. In clay and shale it is often necessary to excavate to a good depth and then partly fill with sand. Drains are sometimes necessary in clayey soils, though not so much in sandy ones. The simplest way of tamping track is to use the material thrown out of the trench. The tracks are tamped on sub-grade before running ballast trains over it, and thus springing of rails is prevented. Tamping bars are used on gravel and sand and tamping picks on broken stone. The author describes one or two methods of construction used by the Cleveland City Railway Co., but considers that the most satisfactory is concrete under and between the ties after the rail is laid. Ties are next dealt with, and the one most highly recommended is the Carnegie steel tie [see Abstract No. 1677 (1905)]. The ties are spaced 6 ft. and the concrete is tamped 4 in. under the tie and 10 in. along and under the rail. Tie-rods are placed over each tie. All objections to steel ties buckling and deteriorating seem to have been removed by the present shape of this tie. Care has to be taken in cross bonding, as the action of the current in passing from one rail to the other through the tie rods and steel ties causes more or less eating away of the ties and rails where they are in contact. Tables are given showing that the steel tie laid in concrete is cheaper than the white-oak tie, this on the assumption that white-oak ties cost 80 cents apiece, the life being about 12 years, and that of the steel tie about 20 years. First class, 1 : 3 : 6, concrete should be used, and this will take the place of the tie in carrying the rail, and should be brought up to within 1 in. of the bottom of pavement. Sketches are given showing the different classes of construction on which the estimates were based. Illustrations also show the effect of different foundations on the pavements. C. E. A.

80. *The Maximus Brake.* (Engineer, 102. p. 484, Nov. 9, 1906.)—A brake designed to give a pressure which shall vary with the speed, which is the essential feature of a good and efficient brake, has been designed by the Maximus Brake Syndicate, Ltd. The makers claim that their brake applies

a varying retarding force 160 per cent. or more of the weight of the vehicle at the commencement of the application, and as the train comes to a stand-still it gradually automatically reduces this to 80 per cent., which works out at an average retarding force of 120 per cent. of the weight of the vehicle. The object of the brake is to effect a constant retardation, the varying pressure equalising the inversely varying coefficient at the changing speeds. The Fig. shows the brake applied to coaches already fitted with the vacuum system [one end of coach only shown, the other end is identical]. A is the brake cylinder. The piston rod is connected by a lever to a rocking shaft B, in the centre of which there are two arms x, x to the ends of which there are attached the pull rods C and C′, and the check rods J J′. Power is transmitted through the pull rods to the brake blocks D and D′. [The letters with index mark relate to the half not shown.] The latter are carried by the bell-crank levers F and F′, which are attached to the hangers E and E′. These bell-crank levers are mounted on square shafts N, which extend trans-





versely across the car. An illustration is also given showing a ratchet arrangement which, when in action, prevents the check rod from moving in that direction, thus preventing any more powerful application of the brakes. It is only when the brake is severely applied that its chief features are emphasised. The strength of the springs having been made to suit a prearranged coefficient of resistance between the brake block and the tyre, as soon as the speed of the coach is reduced until this condition is fulfilled, the brake blocks are drawn up. Gradually, as the speed becomes less, the brake blocks move back into their normal position, and the system becomes rearranged. A diagram is also given showing the plotted results of various trials of brakes which were carried out on the North-Eastern Railway Co.'s system. C. E. A.

81. *Advantages and Disadvantages of different Systems of Tramway Brakes.* **Scholtes and Bjorkegren.** (Electrician, 57. pp. 820–823, Sept. 7, 1906. From "Réponses aux Questionnaires." Report to the Union Internationale de Tramways et de Chemins de Fer d'Intérêt Local at Milan. Elettricità,

Milan, 27. pp. 268–271, Oct. 26, and pp. 282–285, Nov. 2, 1906. Elekt. Bahnen, 4. pp. 696–698, Dec. 24, 1906.)—The former author is director of the Nuremberg-Fürth Tramways, and the latter is chief engineer of the Grosse Berliner Tramways Co. They presented separate reports on the question of tramway brakes on the occasion of the general meeting of the Congress, as their conclusions were too divergent to be incorporated in a single report. The report by Scholtes contains a table of the classification of the number of cars and undertakings employing respectively hand, electric, and air brakes. From this table it is seen that hand brakes are used in the case of lighter cars; it is also good practice to rely upon hand brakes in the case of somewhat heavier cars when the conditions of service restrict the schedule speeds to low values, and where the roads are very level; in other cases, however, resort must be had either to electric or to air brakes. In the case of electric brakes, hand brakes must also be supplied, and are regularly used to bring the car to a final stop; they are, however, not applied until the car is almost at a standstill, and the wear on the brake shoe is thus correspondingly low. Scholtes gives interesting data of measurements made in Berlin, Leipzig, and Nuremberg, on the additional energy required for the compression of the air, reduced to watt-hours per car-mile. The table is as follows:—

Place.	Type of Motor Car.	Tare.	Additional Energy for Compression of Air, in Watt-hours.	
			Per Car-mile.	Per Ton-mile.
Berlin	Two-axle	8 to 9 tons	65	7·7
	Four-axle	12 to 13 tons	109	8·7
Leipzig	Two-axle	7 to 8 tons	65	8·7
Nuremberg	Four-axle	11 to 12 tons	51	4·5

In the next table is given the annual cost of compressed air for a number of plants:—

Undertakings.	Motor Car-miles run in 1904.	Annual Cost of Compressed Air.	
		Kw.-hours.	£
Berlin Tramways	34,168,200	2,204,400	11,022
Leipzig Tramways	7,825,640	504,880	2,524
Hanover Tramways	5,582,480	361,800	1,809
Munich Tramways	4,962,480	320,160	1,601
Nuremberg-Fürth Tramways	3,159,280	203,760	1,019
Crefeld Tramways	1,404,300	90,600	453

This latter table presupposes that in the undertakings mentioned the whole of the motor cars are equipped with air brakes, that the additional energy is the mean of the figures mentioned above, *i.e.*, 65 watt-hours per car-mile, and lastly that the price per kw.-hour is 1·2d. No account of the use

of trailers is taken in this table. The first cost of hand brakes, electric brakes, and air brakes, and the annual cost of maintenance are estimated by Scholtes to have the values given in the following table :—

Systems of Brake.	First Cost.		Annual Cost of Maintenance.	
	Per Motor Car.	Per Trailer.	Per Car.	Per Car-mile.
	£ s.	£ s.	£ s.	d.
Hand Brake......	Included in to	tal cost of car.	4 8	0·04
Electric Brake...	14 10	18 15	2 12	0·027
Air Brake.........	60 0	9 10	10 6[1]	0·064

[1] To this figure must be added the cost of compressing the air—namely, 0·077d. per motor car-mile.

From this table it is seen that not only are the first costs of the electric brake much less than those of the air brake but that the costs of maintenance are much lower than those for the air brake or hand brake. Scholtes ascribes this considerable difference in the cost of maintenance in favour of the electric brake to the practical elimination of the wear of the brake shoes. The cost of installing electric brakes to trailers is heavier owing to the need for the provision of either disc or solenoid brakes, whereas on the motor-car it suffices to short-circuit the motor through suitable resistances. Scholtes states that the Leipzig Tramways Co. mentions in its reply, when dealing with the comparative cost of maintenance of electric and air brakes, that account should be taken of the cost of the increased maintenance of armatures, bearings, brushes, and gearing. Unfortunately the data do not allow this point to be cleared up. At Leipzig these expenses rose to £8 8s. per car per annum ; at Nuremberg they are less. The final conclusions arrived at by Scholtes are as follows : 1. In the choice of a brake system all the particular circumstances of the service should be taken into account. The application of each of the three systems, hand brake, electric brake, and air brake, should be carefully studied. Braking should take place without shocks. The equipment of the car should include two systems of brakes, completely independent of one another. The brake in general use should not cause fatigue to the driver. 2. When, on account of the weight of the cars, on account of trailers, or on account of difficulties of the route, the hand brake cannot rationally be employed, a mechanical brake should be used, preferably an electric brake. 3. If the use of an electric brake for general purposes necessitates certain inconveniences, such as, for example, the choice of too large a motor, or too much graduation in the starting resistances, in such a case it would be well to employ a compressed-air brake. The use of the latter system would be a necessity in the case of the cars being heavy or running at a high speed, or in the event of trains including more than two trailers.

Bjorkegren's report inclines to the conclusion that air brakes are on the whole to be preferred in spite of the slightly greater outlay as regards both first cost and maintenance. Bjorkegren points out that in addition to the readily definable cost of the electric brake, there are certain costs which are much more difficult to estimate ; thus, where electric brakes are required a

considerably larger motor must be installed, and the controller must also be more expensive. Furthermore, the rate of deterioration in both of these elements is higher when electric brakes are used. The first cost of an air brake for a motor car and trailer is, in his opinion, only slightly greater than that of installing an electric brake. He further states that it is as yet too early to give any reliable figures as to the relative cost of maintenance of the two systems. As soon as the electric motor is no longer used exclusively for the propulsion of the car, but for an opposite purpose, generating a certain amount of electrical energy for braking, the cost of maintenance of the motor becomes greater on account of electric braking than it would be with air brakes. The electric brake, besides having the disadvantage of being dependent on the trolley line, has a further disadvantage—viz., that its action is not always immediate. This delay, even if it is but for a second, is enough to give the driver a feeling of want of confidence in his brake. Moreover, this feeling, coupled with other considerations of convenience—for example, the electric brake should always be combined with a hand brake—make the drivers on the Berlin Tramways prefer the air brake and request its general application. Bjorkegren is of opinion that working under conditions analogous to those in Berlin the two systems of brakes have the same degree of safety; for undertakings having long and severe gradients on the contrary, and where blocks may be possible, he is of opinion that the electric brake should not be recommended, for in those cases account must be taken of the danger of short-circuits in the brake equipment. The use of the air brake presents, in addition, for undertakings working under such conditions, the advantage of being able to make the braking automatic in the case of trailers if the coupling breaks. When it is a question of undertakings working cars or trains consisting of heavy vehicles running at high speeds on suburban lines, in this case also air brakes should be preferred, for the small supplementary cost entailed gives greater safety as compensation. It should be remarked, further, that in such undertakings the other costs increase in such proportions that the cost of braking becomes insignificant. Bjorkegren sums up that from the point of view of safety the air brake may be used in all kinds of undertakings; the electric brake, on the other hand, can only be used in certain cases. He considers that Scholtes' conclusions should be amended to read as follows: 1. In the choice of a system of brakes all the particular circumstances of the case should be considered. The application of each of the three systems—hand brake, electric brake, and air brake—should be carefully studied. The brake for general use should allow of braking without shock and should not cause fatigue to the driver. It should, at the same time, be suitable for use in case of emergency, and as such, should work sufficiently rapidly and certainly. In addition to this brake for general use, the equipment of the car should include a second brake (an auxiliary brake). 2. When on account of the weight of the cars the use of trailers, or on account of the route the hand brake, can no longer be rationally used as a service brake, a mechanical brake should be used—either an electric brake or an air brake. H. M. H.

82. *Composition of Cast-iron Wheels.* **J. Andrews.** (Street Rly. Journ. 28. pp. 1088–1090, Dec. 8, 1906. Electrician, 58. pp. 423–424, Dec. 28, 1906. Abstract.)—Discusses cast-iron wheels mainly from the point of view of chemical composition, although it is not overlooked that foundry practice plays a most important part in producing good wheels. Si above 0·6 to 0·7 gives a soft, weak wheel; S below 0·14 to 0·16 with ordinary carbons

gives softness; and high carbons, up to 4·0 and 4·1, are recommended to give strength and hardness. An instance in point is that of wheels which gave good service under cars on steam railways, but chipped at the flange in street railway service, owing to hardness of points, &c. Their composition was: graphitic C 2·74 per cent., combined C 1·08, Mn 0·44, S 0·175. Upon changing the composition to graphitic C 2·94, combined C 0·86, Mn 0·52, S 0·174, flanges were not often chipped, but mileage was reduced. Satisfaction was obtained, however, when the average composition was: graphitic C 2·94, combined C 0·92, Mn 0·48, and S 0·178. F. R.

83. *Electrically operated Points and Signals at Didcot.* (Engineering, 82. pp. 552, 553, 554–555, Oct. 26, and pp. 586, 587, and 588–590, Nov. 2, 1906.)—This installation was put in by Siemens Bros. and Co., and is similar to that at Derby, described in Abstract No. 1159 (1905). The frame in the signal-box is of a different design. The electric motors and gears for points and signals are of the same character as those installed at Derby. At the latter station mercury treadles are, however, used, by which a vehicle passing over the track automatically puts the signals to danger, thus affording added security. At Didcot fouling-bars are used, which cause the point levers to be locked when vehicles happen to be resting on the bars. The present box takes the place of two boxes formerly employed with manually worked arrangements. The current is supplied from secondary batteries which are charged from the power station. The battery-room is located in a separate building near the signal cabin. The cells are divided into three sets, each set being made up of four groups of 16 (120-amp.-hour) cells each. For the power circuits the cells of each set are grouped in series, giving an available pressure of about 128 volts, whilst on the detector circuits they are grouped in parallel, so that these circuits are run at 32 volts only. During charging the cells of a set are grouped in series parallel, making the pressure 64 volts, which is necessary since the pressure available on the charging line is insufficient to charge the cells in series. The switchboard, with the instruments and commutators, is fitted up in a room immediately under the floor of the signal cabin, which, in the case of a "manual frame," would be taken up by the interlocking gear and the rods to the points and signals. This room at Didcot also serves as a store for spare parts; and with regard to these it may be noted that a point motor, for instance, can be taken out and replaced by a new one in 2 min. E. O. W.

ELECTRIC LAMPS AND LIGHTING.

84. *The Metallic Arc.* **I. Ladoff.** (Écl. Électr. 49. pp. 281–294, Nov. 24, and pp. 361–369, Dec. 8, 1906.)—The author gives a summary of present knowledge relating to the manufacture and use of "flame arc" electrodes. In confirmation of the theories expounded, a series of tables and diagrams are given. Particular attention, however, is devoted to the use of ferro-titanium electrodes, with the use of which the author is particularly concerned, and the result of many experiments conducted by the author are given indicating the lines on which further researches should be made. The alloys of titanium seem also to give very satisfactory results. It is possible to burn such electrodes for a period exceeding 100 hours in one trimming. [See also Abstract No. 1050 (1905).] L. G.

85. *The Transformation of Electric Power into Light.* **C. P. Steinmetz.** (Amer. Inst. Elect. Engin., Proc. 25. pp. 755–779, Nov., 1906. Abstracts

in Electrical World, 48. pp. 1041–1044, Dec. 1, 1906. Electrician, 58. pp. 497–500, Jan. 11, 1907.)—Since the light-efficiency of the ordinary incandescent lamp is only a fraction of 1 per cent., there is plenty of scope for improvement. The vapour tension of the material forming the filament at given temperatures is the most important quality that has to be considered in incandescent lighting. Although the boiling-point of carbon is 3,500° C., yet the temperature of the filament of a carbon glow-lamp is only about 1,800° C., for at this temperature the evaporation of the carbon is beginning to increase so rapidly that it seriously shortens the life of the filament. The crater of the carbon arc lamp probably attains the highest temperature that can be reached, and its efficiency is about 2 candles per watt. The efficiency of the glow-lamp is only about ¼ candle per watt. The efficiency can be increased by using filaments made from the metals osmium, tantalum, tungsten (Wolfram), which have a lower melting- or boiling-point than carbon, but have a lower vapour tension at high temperatures. The efficiencies of the tantalum, osmium, and tungsten filaments are 0·5, 0·7, and 1 mean spherical candle per watt respectively. The efficiency of the metallised carbon filament is greater than that of the ordinary filament. This is probably due to an allotropic modification of the carbon making the vapour tension less at the given high temperature. The high efficiency of the tungsten and osmium filaments is probably partly due to selective radiation. The problem of efficient light production consists of producing as many radiations by vibrations of the molecules or the atoms of the light-giving body as possible, of frequencies within the limited range of visible radiation, and as few radiations as possible having wave-lengths outside this range. A vibration of definite pitch—that is, a vibration that will produce a definite colour radiation—can only occur in a gas. But the energy put into a gas by heating it is mainly utilised in increasing the kinetic energy of the molecules, and so increasing the pressure of the gas. To set the gas molecules in vibration, so as to make it luminous, we have to apply electric stress or utilise chemical reactions. For luminous gases or vapours the laws of black-body radiation do not apply. In a solid black body the mean wave-length decreases with increasing temperature, the light radiation changing from red to white. With mercury vapour this is not the case. The spectrum of mercury vapour at temperatures only sufficiently high to make it visible consists of colour lines in greenish-yellow, green, dark-green, blue, violet, and there are many ultra-violet rays. At higher temperatures (less than 1,800° C.), however, the mercury molecule begins to execute a vibration of lower frequency, and intense red lines appear in the spectrum. The light emitted by mercury vapour thus changes from green to white, and ultimately to reddish pink at high temperatures. It is concluded that the efficiency of a luminous gas is higher the lower the temperature. This accounts for the high efficiency of the mercury arc. The light-equivalent of the power radiated from a luminous gas is a function of the wave-length. It is zero in the infra-red, low in red, a maximum in yellow and green, low in violet, and zero in the ultra-violet. The energy radiated in a beam of 1 c.p. of red light is probably greater than the energy of a beam of 10 c.p. of green light. Light is therefore the physiological conception of some wave-lengths of radiation, but is not a physical quantity that can be measured. When the chief consideration is a high economy in light production, greenish or yellowish light is employed, as in the mercury and flame arc lamps. The efficiency is attained, however, by sacrificing the inefficient colours at the ends of the visible spectrum. The mercury arc is eminently suited for out-

door lighting, and the flame arc lamp for advertising purposes, but for general illumination the light should be similar to daylight. For the electric arc in air the volt-amp. characteristic deduced from theoretical considerations is given as $V = V_0 + a(l + b)/\sqrt{C}$, where V is the p.d. between the electrodes, C the current, l the length of the arc, and a and b are constants. If we keep C constant and vary l and V, the calculated and observed values are in fair agreement. If l be in inches, we have, for the carbon arc in air, $a = 180$, $b = 0{\cdot}88$, and $V_0 = 36$. For the magnetite arc $a = 128$, $b = 0{\cdot}05$, and $V_0 = 30$ gives curves almost identical with the experimental curves. The spectrum of the arc is that of the negative material, and the temperature of the arc is that of the boiling-point of the negative. There are two ways in which we can make the arc luminescent. The first way is by using some material as the negative which gives a luminous spectrum. A spectrum with many lines in the visible range and giving an approximately white light is desirable. The second method is by using a material (carbon) to carry the current which will give a very high temperature to the arc stream, and make the arc stream luminous by feeding some light-giving substance—calcium, for instance, which gives a brilliant spectrum—into the arc from the positive terminal. In the former case the arc has the characteristic of the iron arc or the titanium arc, and in the latter case of the carbon arc. Since the carbon arc is the steadiest, most work has been done in connection with it. The former method, however, has the great advantage that the efficiency does not depend on the temperature of the electrodes. The rate of consumption of the negative electrode can thus be greatly decreased, while the positive electrode, which takes no part in the arc conduction, can be made entirely non-consuming. This method seems a more direct conversion of electric power into light. A drawback to flame arcs is the necessity of ventilation to carry off the smoke. The life of the electrodes is only about 10 hours. For the true luminous arc the intermediate oxide of iron, magnetite (Fe_3O_4), is an excellent electrode, as it is a good conductor, is stable at high and low temperatures, and gives a white spectrum. Copper makes a very suitable positive electrode, as it is cheap, is stable at moderately high temperatures, and carries the heat away with sufficient rapidity not to melt or oxidise appreciably. In all these arcs the vapour stream from the negative is a necessity, and the mercury arc is the simplest, as it can be enclosed in a glass tube. In the present magnetite lamp, the magnetite electrode contains titanium, &c., to prevent the electrode being consumed too rapidly. When the highest possible efficiency—4 candles per watt—is desired, a special device has to be employed to start the arc. In conclusion, it is stated that the luminous arc is the first instance of the commercial application of the direct conversion of electric power into light, without the necessity of using heat as an intermediate form of energy. No possible improvement in incandescent lighting can hope to approach to the efficiency of the green mercury spectrum, the yellow calcium spectrum, or the white titanium spectrum. Typical of these spectra are the mercury arc lamp of practically infinite life and giving light of a bluish-green colour ; the yellow-flame carbon arc, the electrodes of which only last as long as the carbons of the open arc lamp, and the white titanium carbide or magnetite arc, the life of the electrodes of which is at least as long as those of the enclosed arc. A. R.

86. *Location of Lamps and Illuminating Efficiency.* **P. S. Millar.** (Elect. Rev., N.Y. 49. pp. 814–816, Nov. 17, 1906. Abstract of paper read before the Illuminating Engin. Soc., Nov. 9, 1906.)—In order to determine the relative

efficiencies of four different methods of indoor illumination commonly used, namely, ceiling lamps, dropped cord lamps, chandeliers, and wall brackets, the author conducted a series of experiments in a rectangular room approximately 16 ft. long by 11 ft. wide by 12½ ft. high. The results obtained are given in tables. The illumination efficiencies at the different testing stations in the room vary considerably according to the methods employed, but are much influenced by the fact whether the lamps are used bare or with suitable reflectors. Much importance is also attached to the reflecting efficiency of the walls and ceilings. The instrument used to measure the intensity of illumination was an improved Weber photometer. L. G.

87. *Illumination Measurements.* **L. Bloch.** (Elektrotechn. Zeitschr. 27. pp. 1129–1134, Dec. 6, and pp. 1162–1165, Dec. 13, 1906.)—The author describes a method applicable for the determination of the mean horizontal illumination obtained when using different types of lamps, viz., carbon filament lamps, metal filament lamps used naked or in combination with reflectors, arc lamps with or without globes, flame arcs, high-pressure gas, and inverted gas lamps. A series of tables are given, with the aid of which the suggested method of calculation is greatly simplified. The measurement of mean hemispherical illumination is also taken into consideration, and by a series of practical examples, which are numerically worked out, the application of the method described and the use of the table is clearly indicated. Reference is made to street lighting and indoor and outdoor general illumination. [See also Abstracts Nos. 580, 778, and 891 (1906).] L. G.

88. *A Comparison of Carbon, Osmium, and Tantalum Lamps.* **J. T. Morris.** (Electrician, 58. pp. 318–322, Dec. 14, 1906. Écl. Électr. 50. pp. 72–74, Jan. 12, and pp. 103–105, Jan. 19, 1907.)—The first part of the experimental work here described was devoted to the effect on the different types of lamp, when the voltage is slightly changed. At the working voltage a change in pressure of 1 per cent. raises the c.p. of a carbon lamp about 6 or 7 per cent., the corresponding figures for tantalum and osmium lamps being 4·3 and 4·5 per cent. respectively. Curves are given showing the connection between voltage and c.p., between voltage and resistance, and between voltage and efficiency for these lamps over a considerable range. It is pointed out that with tantalum and osmium lamps, and indeed with any type of metallic filament, the load at the moment of switching on cold filaments will be much greater than the working load. With the oscillograph it is found that the current taken by a tantalum lamp at starting is about five times its final value. With alternate current at 30 cycles, it was found that the percentage variation in c.p. of a tantalum lamp during a cycle was 28·2, and with a carbon filament it was 63·9; with 60 cycles, the figures were 15·5 and 26·6 respectively. The ratio of mean spherical to mean horizontal c.p. was 0·78 with carbon lamps, 0·79 with osmium, and 0·755 with tantalum lamps. A table is given containing some of the physical constants of the lamps which were examined. From this it appears that a carbon filament, giving 5 c.p. at 220 volts, is 8·12 in. long, and 2·13 mils in diam. For a tantalum lamp, giving 22 c.p. at 110 volts, the length is 29·13 in., and diam. 1·92 mils. W. H. S.

89. *Tests of Incandescent Lamps.* **L. B. Spinney.** (Electrical World, 48. pp. 1149–1151, Dec. 15, 1906. Electrician, 59. pp. 540–541, Jan. 18, 1907. Abstract.)—The results are given of a series of tests made at the

Iowa State College, where over 1,000 incandescent carbon filament lamps were tested, representing 82 different makes. The lamps ranged in rated c.p. from 1 to 50, the majority being 16 c.p., at voltages from 50 to 225, and in rated consumption from 8·1 to 4 watts per c.p. About 62 per cent. of the 16-c.p. lamps tested were well selected as per target diagram used, but only about 76 per cent. of these lamps were properly exhausted. The author concludes that the incandescent carbon filament lamp as found upon the market (in America) is a variable quantity, and that it is worth while to go to the trouble of proving the quality of lamps purchased. The general results of the tests are set forth in tables and target diagrams. [See also Abstract No. 522 (1906).] L. G.

90. *Carbons for Actinic Light.* (Fr. Pat. 368,882. Rev. Électrique, 6. p. 172, Sept. 30, 1906. Abstract.)—Carbons having five times the effect of ordinary carbons upon silver bromide for the same current consumption, can be obtained, according to L. C. Marquart, by adding to the paste 0·5 per cent. of a mixture of equal parts by weight of the nitrates of yttrium and of lead.

L. H. W.

REFERENCES.

91. *Sources of Danger in Alternating-current Networks and Protective Devices.* **H. Zipp.** (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1908–1915, Nov. 24, 1906. From a paper read before the Sächsisch-Anhaltischer Bezirksverein, Cöthen, March 18, 1906.)—The author considers the danger to life which arises in connection with alternating-current systems under the following heads: (1) Faulty insulation; (2) high electrostatic capacity; (3) voltage rises due to atmospheric disturbances or resonance effects; (4) passage of high potential from high- to low-voltage winding of transformer. The nature of each effect is explained and illustrated by numerical examples, and a brief description is given of suitable safety devices.

A. H.

92. *Methods of increasing Lighting Efficiency and Lighting Load.* **M. Leboucq.** (Soc. Belge Élect., Bull. 23. pp. 542–549, Nov., 1906.)—The author deals with the various factors which tend to bring electric lighting into disrepute—such as bad voltage regulation, poorly designed or badly insulated distributing networks, allowing of excessive voltage drops, and use of low-efficiency lamps. He suggests the desirability of making each consumer thoroughly acquainted with the causes which tend to lower the efficiency of his lighting, and of establishing photometric laboratories at which consumers could have their lamps tested free of charge. A. H.

93. *Capacity Currents in Cables.* **W. Akemann.** (Elektrotechn. Zeitschr. 28. pp. 6–9, Jan. 3, 1907.)—Following Breisig, the author defines the effective capacity of any conductor of a multi-core cable as that capacity which enables us to find the capacity current taken by the conductor under normal working conditions. He investigates the value of this capacity in the usual types of cables, with and without pilot wires, and shows that the effective capacity can in every case be found from two ballistic measurements. A. H.

94. *Experimental Track at Oranienburg.* **Meyer.** (Elekt. Bahnen, 4. pp. 669–670, Dec. 14, 1906.)—A brief description is given of the experimental track recently laid down at Oranienburg by the Prussian State Railway authorities for the purpose of carrying out various tests on track construction and studying new systems of traction. The track consists of two 250 m. parallel straight-line portions, 400 m. apart, closed at each end by semicircular portions of 200 m. radius, the elevation of the outer rails being sufficient to allow of a maximum speed of 50 km./hour. A. H.

TELEGRAPHY AND TELEPHONY.

95. *Multiplex Telegraphy.* (Elektrotechnik u. Maschinenbau, 24. p. 1088, Dec. 16, 1906.)—This patent specification of G. Seidl (Ö.P. 25,888) describes means of operating from Hughes' apparatus in quadruplex. Relays connected in bridge are acted upon by currents of different strengths from different keys, the home relays being unaffected when one station only is sending. The tongues of the relays are appropriately connected to permit of the receiving apparatus functioning in a regular manner. E. O. W.

96. *The Carborundum Wireless Detector.* **G. W. Pickard.** (Electrical World, 48. pp. 994–995, Nov. 24, 1906.)—Referring to the carborundum coherer [see Abstract No. 1789A (1906)] the author gives some particulars as to the behaviour of a receiver of this type. The curve plotted between applied volts and resistance (in reciprocal megohms = micro-mhos) shows that the greatest rate of change of resistance takes place between 1·0 and 1·1 volts; and this was confirmed by inserting the receiver in a wireless aerial circuit, the max. response being obtained at 1·0–1·2 volts in the local circuit. The detector is classed as belonging to the bolometric receivers [?], the edge contacts of the crystal with a plane surface forming the constricted current paths in a material of high specific resistance and high temperature-coefficient. Without stating how the measurement was made, the author gives for the number of micro-ergs required to give a just audible dot with the electrolytic, the magnetic, and the carborundum detectors the following figures: 364–400, 400, 9,000–14,000 respectively. The carborundum detector is hence, on this basis, much less sensitive than the electrolytic or the magnetic, and is also stated to be much less constant in its action.
L. H. W.

97. *Wireless Telegraphy and Auroræ.* **C. J. Stuart.** (Science, 24. pp. 694–695, Nov. 30, 1906.)—The author on six nights during the last year recorded observations, in Canada, during spells of Aurora or the brilliant clear weather associated with the Aurora, which show that during these periods it was possible to receive signals and messages over abnormal ranges of 750 to 1,600 miles with apparatus that ordinarily will not operate over more than 250 miles. No sending was possible, and in at least four cases the long-distance signals ceased directly the Aurora ceased or diminished. The author hopes the matter may be looked into by others better equipped for the investigation.
L. H. W.

98. *The Arc in Wireless Telegraphy.* (Electrician, 58. pp. 874–876, Dec. 21, 1906.)—In this editorial the development of the arc method of producing high-frequency oscillations is reviewed. Referring to Poulsen's method [Abstract No. 1473 (1906)] it is pointed out that the chief originality lies in the mechanism employed to keep the arc constant. The physical difficulties as regards the maintenance of an arc in hydrogen are considerable. E. Thomson's claim that the method has been anticipated by him is contested, and the difference between the arc method proper and Thomson's method pointed out [see next Abstract]. Coming to the physical phenomena involved, it is observed that the upper limit of frequency (<100,000 per sec.) laid down

by Duddell probably exists in reality; and since Poulsen employs unsymmetrical electrodes and a strong magnetic field, it is held to be not yet definitely established that Poulsen's arc is a musical arc, and that he is really obtaining continuous trains of undamped oscillations. The smallness of potential amplitude in arc-made waves is usually asserted to be compensated for by the increased ability to utilise the effects of resonance more completely; but it has not yet been proved that such compensation is adequate. The final conclusions arrived at are very similar to those of Hahnemann [Abstract No. 1474 (1906)]. L. H. W.

99. *Undamped Oscillations for Wireless Telegraphy.* **Elihu Thomson.** (Electrician, 58. pp. 878–880, Dec. 21, 1906.)—Referring to Poulsen's method [see Abstract No. 1478 (1906)] the author in this letter calls attention to his own method described in U.S. Patent No. 500,680, issued in 1898. Thomson's method is to establish from a direct-current supply an arc discharge between two separated ball electrodes and to extinguish such arc by means of an air-jet; such extinction causes the current passing through the gap to be diverted through a circuit, in shunt to the gap, containing capacity and inductance. The charging of the capacity momentarily stops the discharge across the gap owing to the presence of a coil of considerable self-induction in the supply circuit; and the condenser, when charged, discharges through the gap, again starting the process. Frequencies up to 50,000 per sec. were obtained by this means. In an editorial [see preceding Abstract] the difference between the arc method and the author's method is pointed out. L. H. W.

100. *Directed Wireless Telegraphy. Ascertaining Direction of Transmitting Stations.* (Brit. Pat. 8,127 of 1906. Engineer, 102. p. 590, Dec. 7, 1906. Abstract.)—This patent of G. Marconi and Marconi's Wireless Telegraph Co. deals with applications of the horizontal aerial [Abstract No. 655 (1906)]. A number of horizontal wires are laid out, like the spokes of a wheel, and by means of a rotating switch any one can be connected through the spark-gap at the transmitter to earth. When used for receiving, the direction of the transmitter station is ascertained by rotating the switch until a maximum of sound is heard in the telephone connected to the magnetic detector; in this case the aerial will point away from the transmitting station. The strength of the signals is judged at short distances by shunting the detector until the signals are only just audible. In U.S. Pat. 888,084 L. de Forest (West. Electn. 39. p. 417, Nov. 24, 1906) describes a method of getting the bearings of a transmitting station, employing also inclined aerials, but necessitating the use of a complicated arrangement for which the original should be consulted. L. H. W.

101. *Wireless Telephony.* (Electrical World, 48. p. 1107, Dec. 8, 1906.)—A brief notice of a wireless telephone transmitter recently patented by L. de Forest. An inductance coil is earthed through a spark-gap S_1. A condenser in series with a second spark-gap is connected between the lower end of the coil and an intermediate point of it. Another intermediate point, higher up the coil, is in connection with the antennæ. An alternator is connected across the condenser. A nozzle connected with a compressed-air reservoir is directed across the spark-gap S_1, and by means of a megaphone, whose diaphragm operates on a reducing valve included in the pipe supplying the nozzle, a variable flow of air against the spark-gap is produced (U.S. Pats. 886,015; 886,072). A. H.

SCIENCE ABSTRACTS.

Section B.—ELECTRICAL ENGINEERING.

FEBRUARY 1907.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

102. *Ehrhart's Steam Turbine.* (Mech. Eng. 18. p. 849, Dec. 15, 1906.)—This design is due to R. N. Ehrhart, of Pittsburg, and provides an efficient high-pressure section, utilising the reconversion principle, with a low-pressure section of impulse and reaction blading of the Parsons type. It is illustrated by two woodcuts showing partial longitudinal sections. The steam is expanded in nozzles, and a fraction of the velocity energy due to the nozzle expansion is absorbed by a single row of impulse blades. A single row of such blades is shown on either side of the main steam opening. Leaving these impulse blades, the steam collects in transforming receiving chambers so proportioned that the velocity energy is retransformed into pressure energy, and the inlets of these chambers are provided with guide vanes to prevent the rotation of the steam issuing from the impulse blades. Thereafter the steam is expanded down to exhaust pressure through alternate rows of fixed and movable vanes.

F. J. R.

103. *Steam Turbine Characteristics.* **H. Holzwarth.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 433–457, Nov., 1906.)—The indicator diagram, which is used with reciprocating engines to give the characteristics of its thermodynamic qualities, cannot be so applied to steam turbines, and the author proposes a logarithmic diagram, of which he gives specimens along with elaborate calculations showing its application. A specimen of the Mollier diagram [Abstract No. 961 (1904)], applicable to the elucidation of such questions as those of the influence of moist and superheated steam, and the effect of throttling steam with a regulating valve, is also given. In an appendix these diagrams are used for working out definite problems in turbine design, and velocity diagrams are added. The author considers that the slide rule is, with this system, the only instrument required in working out the characteristics of steam turbines.

F. J. R.

104. *Test of a 500-kw. Melms and Pfenninger Steam Turbine.* **M. Schröter.** (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1811–1821, Nov. 10; 1862–1867, Nov. 17, and pp. 1955–1956, Dec. 1, 1906.)—The results of the test dealt with in Abstract No. 1002 (1906) have been worked out and are here fully given and discussed. In the supplementary communication the working of the turbine under the steam conditions determined by the throttle regulator is examined and compared with the theoretical or perfect turbine. By substituting in the earlier calculations of indicated efficiency the steam conditions before the first guide blading (after the throttle valve), the remarkable result is found that the indicated efficiency, as applied to the perfect turbine, then has its maximum at ½ load in place of at maximum load. Whether this is a property of this particular turbine or is characteristic of all Parsons type turbines is not known. L. H. W.

105. *Turbine Theory.* **L. Lecornu.** (Comptes Rendus, 144. pp. 23–25, Jan. 7, 1907.)—This paper gives the theory relating to turbines with flexible axes. Experiment has shown that the best means of counteracting the effects due to inertia consist in allowing the axis to possess a certain degree of flexibility. But this flexibility has the inconvenience of allowing the centre of gravity to have varying displacements from the geometrical axis. Taking the problem in its simplest form, consider the motion of a plane disc at the middle of the axle and perpendicular to it. Suppose that when it leaves the postion of static equilibrium it is acted on by a restoring force applied at a point A, which, in the position of rest, coincides with a point O on the axis, the force being proportional to the displacement OA and directed from A to O. Assuming that the external forces are in equilibrium with respect to the axis of rotation, what is the motion of the centre of gravity? Previous workers have neglected the small relative variations of the angular velocity of the disc. Let a denote the constant length GA, M the mass of the disc, $MK^2.OA$ the restoring force applied at A, and c the radius of gyration relative to the centre of gravity. Neglecting the solution $\lambda = K^2a/(\omega^2 - K^2)$, which can only be realised by a combination of exceptional circumstances, and which shows the existence of a critical value $\omega = K$ for which λ tends to increase without limit, the problem can only be solved by approximate methods. Neglecting the square of a/c, the movement of the centre of gravity results from the compounding of a uniform rotation of velocity ω on a circumference of radius λ, with an elliptic motion, having a central acceleration, whose period is $2\pi/K$. Taking count of the square of a/c, the preceding ellipse must be considered to possess a uniform rotation round its centre whose velocity is $[K^4\omega/(K^2 - \omega^2)^2]\,a^2/2c^2$. This rotation is the more rapid as the critical velocity is reached. To the same degree of approximation the motion is disturbed by numerous small oscillations of varying periods, so that the ellipse only represents a mean motion which approximates to the real motion of the centre of gravity. The amplitude of the displacements increases as the critical velocity is reached, and near this velocity the phenomenon obeys no simple law. A. W.

106. *Steam Turbine Improvements.* (Elektrotechnik. u. Maschinenbau, 25. p. 87, Jan. 27, 1907.)—The Maschinenfabrik Grevenbroich suggests a method for the improvement of the steam turbine by utilising the compression thrust arising from the high velocity of the steam in the nozzles. By a proper expansion of the steam after the point where the compression thrust occurs,

the pressure-excess is made to impart additional velocity to the steam. This is secured by widening the steam passage on from the thrust-point in a determinate ratio, depending on the pressure at the thrust-point and on the back pressure. A. W.

107. *Steam Turbines with Injection Condensers.* **F. Niethammer**. (Zeitschr. ges. Turbinenwesen, 4. pp. 13–14, Jan. 10, 1907.)—Steam-turbine manufacturers prefer surface condensers to injection condensers. The author states that steam turbines with injection condensers do not provide vacua higher than some 80 per cent. as against some 90 to 95 per cent. with surface condensers with cooling water of sufficient quantity and of sufficiently low temperature. Since a single per cent. variation in vacuum greatly affects the steam consumption of a steam turbine, the surface condenser is consequently greatly to be preferred. On the other hand, injection condensers are so much cheaper than good surface condensers that a total saving of some 5 per cent. on the total cost of turbine, dynamo, and condenser plant is obtained by its adoption. The writer describes some operating difficulties which have been encountered with injection condensers when employed in connection with steam-turbine plant.
H. M. H.

108. *Steam Engines at the Reichenberg Exhibition.* **K. Körner**. (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1493–1498, Sept. 15; 1709–1713, Oct. 20; and pp. 1951–1954, Dec. 1, 1906.)—Among the different exhibits described and illustrated the 40-h.p. Schmidt-type superheated steam tandem-compound condensing engine built by the Maschinenbau-A.G. Breitfeld, Daněk and Co. appears to present some special features. The single-cylinder structure comprises three spaces all surrounded by the same steam jacket, which is at the same time the receiver. The front space is the ordinary l.p. piston steam space; this is constantly open to the receiver. The next is a space which is partly filled by the trunk piston which passes through it on its way to and itself forming the h.p. piston. The third space is the h.p. steam cylinder. Each cylinder has only a single inlet valve and a single exhaust valve. On the forward stroke the trunk piston has the h.p. steam acting on its piston and the receiver pressure acting, in the central space, on the *difference* between the two cylinder areas. On the return stroke, however, the h.p. and central spaces are respectively open to the receiver and the condenser. By this arrangement, in spite of the single-acting operation, the engine behaves like a double-acting engine so far as the distribution of the crank forces are concerned. With an admission pressure of 11 atm. and 330° C. steam temperature the guaranteed steam consumption is only 4·8 kg. (10·56 lbs.) per i.h.p.-hour, and for larger sizes is as low as 4·2 kg. These good results are attributed to the compact construction employed and the absence of receiver piping. L. H. W.

109. *Steam Losses due to Drainage in Steam Engines.* **Josse**. (Zeitschr. der Dampfkessel-Untersuchungs-u. Versicherungs-Gesell., May, 1906. Elektrotechnik u. Maschinenbau, 24. p. 571, July 8, 1906. Abstract.)—From experiments with a 200-h.p. triple-expansion engine at Charlottenburg it was found that the steam losses in five drainage vessels as a result of faulty closing amounted to, roughly, 5·8 per cent. of the total steam consumption, in spite of most careful attendance. The loss would naturally be much greater in ordinary working. L. H. W.

110. *Direct Leakage of Steam through Slide Valves.* **J. V. Stanford.** (Frank. Inst., Journ. 162. pp. 467–471, Dec., 1906.)—Experiments made with the 6 in. × 9 in. steam engine of a Sturtevant fan, the valve being of the ordinary D slide valve type 5 in. wide by 4¾ in. long, overlapping the ends of the ports by ¼ in. on each side, showed 91·2 lbs. steam per i.h.p.-hour used when the engine was developing 5·18 h.p., a balance-plate with springs being used to relieve the pressure between valve and seat. Without the balance-plate the steam consumption was 60·5 lbs. With steam ports plugged and valve moved by a motor at ordinary rate of running, the leakage with balance-plate on was 48·9 per cent. of the total steam consumption, and with balance-plate removed 18·9 per cent. With the balance-plate the power required to drive the valve was 0·25 h.p., which was unaffected by increased steam pressure; but without the balance-plate the power increased to 0·88 h.p. for the pressures previously tried. The great amount of leakage took place only when the valve was moving, so that the standing test for valve leakage is misleading. F. J. R.

111. *Heat-interchanges in Engine Cylinders.* **A. Duchesne.** (Eng. Mag. 32. pp. 425–427, Dec., 1906. Abstract from Revue de Mécanique, 1906.)—In pursuance of the work of Dwelshanvers-Dery, Boulvin, and others, the author has employed thermoelectric couples of platinum and silver to measure temperature-changes in the steam and the cylinder walls. The thermo-junctions are placed within 1 mm. of the inner surface of the cylinder walls, and those for the steam in the clearance spaces. The engine experimented with is in the laboratory of the University of Liége, and has movable heads to vary the clearance spaces, and consequently the compression. Details of the thermoelectric apparatus, and also curves plotted from the results obtained, are contained in the original paper. The thermal diagrams are accompanied by indicator diagrams showing the corresponding pressures. The temperatures in the cylinder during admission and expansion with saturated steam agree with those of successive pressures given in Regnault's tables. Hirn's theory of condensation during expansion was also verified. At the beginning of exhaust the measured and tabulated temperatures of steam differed by 1° to 2° C., but a tendency to superheating was noticed when compression commenced, and at the end of compression the steam was much hotter than the cylinder walls. Steam of an initial pressure of 5·7 kg. per sq. cm. (81 lbs. per sq. in.), with initial temperature of 156° C., showed 275° C. at end of compression, dropping to 156° C. at beginning of next admission, the cylinder walls being 130° to 155° C. lower than the steam temperature. At the end of expansion the steam is about 20° cooler than the cylinder walls. The application of such measurements to steam turbines is recommended. F. J. R.

112. *Improved Boiler and Setting for Bituminous Coal.* **A. Bement.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 245–254, Nov.; Discussion, pp. 874–879, Dec., 1906.)—An elevation, partly in section, shows a water-tube boiler of the Babcock-Wilcox type, with chain-grate stoker slightly projecting in front of boiler, with an arched brick roof over the grate. Inside the boiler casing a sloping brick roof, formed of hollow tiles supported on the bottom row of tubes, extends from the front headers to about two-thirds of the tube length, a portion being over the rear end of the grate and the rest over a combustion space behind the bridge wall. Baffle-plates are placed vertically amongst the tubes, and the gases are taken up and down through the whole

of the tubes from back to front, where they finally escape upwards to the chimney. The smokelessness of the system is illustrated by photographic views of the chimneys of several installations. In the *discussion*, **L. P. Breckenridge** confirmed the importance of the tile roof furnace with chain-grate stokers. **W. D. Ennis** quoted instances of bad proportions in flue spacing and of the useful effect of retarders. **W. Kent** proposed to add to the author's design some provision for an adjustable supply of air for an increased rate of feeding coal in forcing boilers. He was sceptical about the advantage of "balanced draught," as tests showed that greatly different pressures of draught may give the same constitution of escaping gas. F. J. R.

113. *Wagner's Water-tube Boiler.* (Engineering, 83. p. 34, Jan. 4, 1907.) —Abstract of patent (No. 14,583 of 1906) of H. W. Wagner, of Moscow, for a boiler composed of U-shaped water-tubes placed horizontally with a horizontal steam and water drum above the tubes. The water-level is at about one-third of the height of the drum, and the grate is placed between the upper and lower limbs of the water-tubes. The gases first ascend to the under side of the drum, and then descend through the water-tubes at the bend, and finally pass to the flue through the tubes at their lower limbs.

F. J. R.

114. *Effects of Feed Regulators on Superheating.* **W. E. Crane.** (Power, 26. pp. 795–796, Dec., 1906.)—A steady feed induces the best working of boilers; a uniform water-level, not too high, ensuring a uniform quality of the driest steam the boiler can yield. Superheating can take place only when steam is dry. The author advocates the use of automatic regulators of feed-water, and shows the following results of hand and automatic feed regulation. In the hand-feed tests a man was specially put on to regulate the water-level from 8 to 5 o'clock :—

Hand-Feed Regulation.					Automatic-Feed Regulation.				
Time, p.m.	Steam Pressure.	Temperature of Steam in Pipe.	Temperature due to Pressure.	Superheat.	Time, p.m.	Steam Pressure.	Temperature of Steam in Pipe.	Temperature due to Pressure.	Superheat.
1	147	389	364	25	1	138	382	359	23
2	145	370	363	7	2	137	380	358	22
3	143	389	362	27	3	130	376	355	21
4	145	402	363	39	4	140	388	361	27
5	145	402	363	39	5	142	390	362	28
6	145	376	363	13	6	140	387	361	26
7	147	377	364	13	7	140	393	361	33
8	147	383	364	19	8	135	391	358	33

F. J. R.

115. *Burning Bituminous Slack and Lignites.* **G. P. Hutchins.** (Electrical World, 49. pp. 45–47, Jan. 5, 1907.)—The author advocates the use of chain-grate or under-feed stokers of the American design with brick arches, and forced draught. Some comparative figures of results with stoker-feed and hand-feed are given, and also results of a test with slack coal stoker-fired

against "run-of-mine" coal hand-fired, the stoker-fired showing an economy of 36 to 41 per cent. in cost, and considerable increase in capacity over the hand-feed with the better quality of coal. F. J. R.

116. *Transmission Dynamometer.* **W. F. Durand.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 425–431, Nov., 1906; Discussion, pp. 965–966, Jan., 1907.)—Gives a description of a modification of the Tatham transmission dynamometer. The instrument is very compact in form, and it is free from the effect of centrifugal force at high speeds. A special feature is the use of the Emery flexible plate instead of pins or knife-edges for the support of the beam, whose motion is limited by means of stops to a range of about ¼ in. at 10 in. from the centre of support. Ball bearings are used throughout to reduce friction to a minimum. The instrument described was used up to 12 h.p. A. W.

117. *Testing Inflammable Gases.* **C. E. Sargent.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 815–823, Dec., 1906.)—The author states that with the increasing demand for internal combustion engines, and the consequent increase in the number of producer plants in operation, there is need for a simple, quick, and efficient method of making calorific and dust tests with samples of producer gas. He has devised two forms of apparatus which fulfil these requirements, and can be placed in the hands of engineers. The essential features of the gas-calorimeter are that the circulating water envelops the whole apparatus, minimising radiation losses, and that the water is weighed not measured, the tipping of the collecting bucket into the weighing vessel being effected automatically at regular intervals of time, the length of which can be varied at will. The chief feature of the dust-collecting apparatus is the substitution of filter-paper for cotton-wool. The author also recommends the use of Fahrenheit thermometers, frequent tests at short intervals (4 min.) rather than one long one, and the calculation of the results directly into B.Th.U. instead of the conversion from one system of units to another. Operating as he recommends with the improved apparatus, the results of one test can be calculated while the next is being made, since owing to the automatic bucket tip the apparatus requires little attention.

J. B. C. K.

118. *Ganz System and Apparatus for Smoke Prevention.* (Zeitschr. der Dampfkessel-Untersuchungs-u. Versicherungs-Gesell., Nov., 1906. Elektrotechnik. u. Maschinenbau, 24. p. 1067, Dec. 30, 1906. Abstract.)—The apparatus consists of a steam-jet with air supply above the fire, and an adjustable smoke regulator or damper. The steam-jet is set in action by the opening of the furnace door, and the damper is at the same time opened to its fullest extent. After a stated time, which can be varied at will, the steam-jet is put out of action, and the damper returns to the normal position, both movements being automatic. The frequency and length of the periods during which the steam-jet is worked, and the final position of the damper, must be suited to the size and design of the furnace and to the character of the fuel burnt. Tests with this apparatus were carried out in Vienna by M. Tejessy with three Tischbein boilers, using coal having a heating value of 6,200 kg.-cals. When the Ganz apparatus was not in use, the efficiency of the boilers during a 7 hours' trial was found to be 74·4 per cent., while this was increased to 81·80 per cent. by use of the smoke-prevention apparatus, and the suppression

of smoke was practically complete. This gain in efficiency was equal to a saving in coal of 9·8 per cent. The steam-jet was in operation only 1½ min. at intervals of 6 min., and by special trials it was found that it consumed only 1 per cent. of the steam generated. J. B. C. K.

119. *Wallace Alcohol Calorimeter.* (Engineer, 102. pp. 619–620, Dec. 21, 1906.)—This calorimeter is reported to combine accuracy with ease of manipulation. The coal is burned in a current of oxygen at normal pressure, inside a combustion chamber which is surrounded by a closed cylindrical chamber containing alcohol. A long glass tube of small bore attached to a graduated scale dips into this alcohol, and permits the expansion of the latter when heated by the combustion of the fuel. The amount of the expansion is a measure of the heat generated. An air-jacket is placed around the alcohol cylinder to minimise radiation losses. The coal is fired by an incandescent platinum wire. The Wallace calorimeter differs from that of Carpenter in the use of alcohol in place of water as the expansion fluid ; this substitution of alcohol for water increases the accuracy of the apparatus and ease of manipulation. The calorimeter is calibrated by burning 0·60 gm. of pure carbon at different temperatures, and by noting the expansion of the alcohol. A curve is then plotted from these values, and by comparing the expansion of the alcohol for the sample of fuel under test with that obtained at the same temperature with pure carbon, the data for ascertaining the calorific value of the sample are obtained. J. B. C. K.

GAS AND OIL ENGINES.

120. *Evolution of Gas Power.* **F. E. Junge.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 168–194, Nov. ; Discussion, pp. 868–878, Dec., 1906, and pp. 941–956, Jan., 1907.)—The author reviews the history of gas-engine practice principally from the theoretical side, comparing by means of diagrams the cycles of the Diesel, the Weidmann continuous combustion, and the Otto engines, to emphasise the essential conditions for regularity of combustion. Plotted diagrams show the performance of Deutz double-zone lignite producers, the increasing application of electric power from central stations in one hundred cities in Germany during the years 1897–1901, and the cost of power from public electricity supply, public gas supply, and own suction gas plant, in 222 towns and districts in England. The survey of the subject includes questions of governing, thermal performance, equipment and working costs, value of fuel, influence of electrical industry on gas-engine development, and comparison of proposals for transmitting electricity and gas over long distances. The data derived from the elements of an ideal diagram of the Otto cycle, and compared with those of the constant-pressure engine, under varying conditions, are placed in an appendix, and it is shown that with equal max. pressures and temperatures the mean effective pressure of the constant-pressure cycle is 18 per cent. higher than that of the Otto cycle ; and for the commercial range equal mean effective pressures are attained in the constant-pressure cycle at lower max. temperatures and pressures, and with a higher degree of thermal efficiency than in the Otto cycle. In the *discussion*, **R. E. Hellmund** thought it was advisable to use motors of the induction type instead of synchronous motors when driven by gas engines, to avoid trouble in consequence of hunting. **W. D. Ennis** compared steam-engine costs and efficiency. **H. Diederichs** observed that although the Diesel engine working on the constant-pressure principle carried the oil engine to a degree of per-

fection not before attained, the constant-pressure gas engine had not been developed to the extent which the promise of its cycle warranted. He gave a three-dimension diagram drawn by isometric projection to show more clearly the relation between the constant-volume and the constant-pressure cycle for the conditions assumed by the author in his calculations. This corroborated the author's conclusions. **J. E. Johnson** showed by argument and illustration that the attempt to regard the blast furnace as an adjunct of the power plant though technically correct is commercially impossible. **C. G. Atwater** questioned some of the author's statements about the use of coke-oven gas, and **A. J. Wood** indicated some errors in the formulæ given in the appendix. **G. J. Rathbone** maintained that controlled ignition will have more influence on development of efficiency in gas engines than any other factor, and that a suitably designed engine will give 1 b.h.p. on 8,000 B.Th.U., and an overload capacity to 85 per cent. with practically uniform efficiency. F. J. R.

121. *Internal Combustion Engines.* **K. Schreber.** (Eng. Mag. 32. pp. 482–488, Dec., 1906. Abstract from Revue Générale des Sciences, 1906.)—The advantages and disadvantages of the method of injecting a spray of water into the interior of the cylinders of internal combustion engines are fully discussed, and in practice it is found that this method lowers the efficiency of the engine, although it protects the cylinder from becoming overheated. The engine of Bánki, of Budapest, in which the vapour of water is used has, however, shown a very high thermal efficiency. The action of this engine is investigated and the reason for its efficiency is shown. The water spray is injected into the mixed charge of air and gas in the suction pipe and is vaporised by the heat of compression. If injected when the temperature of compression reaches that of vaporisation, the compression temperature may be so regulated that higher compression may be used. The author considers the application of this principle to engines employing alcohol instead of hydrocarbon vapour, and shows its superiority over engines using a carburettor. The thermodynamic examination of the action of an engine operating with a liquid fuel such as alcohol, which mixes with water, injected during the middle of the compression portion of the cycle, shows that it should have distinct advantages, and it is to be hoped that such a motor will be submitted to practical and scientific test. Alcohol may be used with success also in the Diesel motor, and this principle may have important effects on internal-combustion motor design. F. J. R.

122. *Injection of Water in the Cylinders of Motors.* **Quidarré.** (Locomotion Automobile, 18. pp. 484–488, Dec. 29, 1906.)—Referring to the paper of Schreber [see preceding Abstract] and to Witz's treatise on gas engines, the author proposes for two-stroke cycle engines working at constant pressure an arrangement by means of which a spray of water is injected into an annular vaporising space which surrounds the compression chamber at the end of the motor cylinder. The water is to be vaporised by the heat derived from the cylinder walls at the compression space, and is to form a protecting envelope within which the combustible charge burns, the combined gases and steam operating on the piston and becoming mixed towards the end of the stroke. By these means it is held that a high temperature of combustion can be obtained along with prolonged expansion and a lowered temperature of exhaust, the walls of the main cylinder being also protected from contact with the burning gas. The heat radiated by the burning gas completes the vaporisation of the water and superheats the steam, which, it is held, will act on

the piston with only slightly less efficacy than if replaced by gas; and as the main charge of gas will lose less heat through the cylinder walls, the total effect will be improved. This method is designed for engines of small power and for the motors of automobiles. The construction is illustrated by a partial section and plan of main and compressor cylinders, and by a diagram to explain the action of the steam and gas in the motor cylinder.

F. J. R.

123. *Gas-engine Temperatures.* **B. Hopkinson.** (Phil. Mag. 13. pp. 84–95, Jan., 1907.)—This paper gives a description of the determination of the temperatures in the cylinder of a large gas engine by means of a platinum thermometer, the gas engine being motored round with the gas supply cut off, so that it simply compressed and expanded a charge of air. The wire used was 0·004 in. diam. and 29 cm. long. For large engines using high compression thicker wire is necessary, and then the correction for time-lag becomes unmanageably large. The galvanometer circuit was completed once in every two revolutions of the engine shaft by means of a contact-maker carried on the valve shaft, and the moment of contact could be adjusted to any desired point of the cycle. Diagrams are given of the results.

A. W.

124. *Hughes Mechanically-poked Continuous Producer.* (Eng. News, 56. p. 559, Nov. 29, 1906.)—The steel cylindrical shell, lined with firebrick, is mounted upon a cast-iron base ring, which has a water trough and seal and a central blast inlet with deflecting cover, and attached to a turntable running upon conical wheels and driven by spur gearing. The top of the producer is stationary and is fitted with two hoppers, placed to drop the coal at two concentric points, an exit pipe for the gas, and the mechanical poker, which latter is a water-cooled steel casting, pivoted by a trunnion carried by the steel top, and moved to and fro by ratchet gearing from circumference to centre of the producer inside, so that as the producer body rotates the whole of the fuel is brought within its action. The top is water-cooled. The power required to operate a producer of 10 ft. internal diam. is 3 h.p., and the rate of combustion averages 25 lbs. of bituminous coal per hour per sq. foot of producer area, and frequently reaches 30 lbs. The average composition of gas yielded is CO_2, 4; CO, 26; hydrocarbons, 3 to 4; H, 13; and N, 58 per cent. by volume. These producers are made by the Wellman-Seaver-Morgan Co., of Cleveland, Ohio.

F. J. R.

125. *New Types of Suction Gas-producers.* **Wesselsky.** (Gasmotorentechnik, 6. pp. 133–135, Dec., 1906.)—The author deals with progress in the suction gas-producer industry, and describes the producer introduced by the Gas-Generator Co., of Hainsberg-Dresden, for use with anthracite and coke breeze or dust. Comparative tests made with this producer and with producers using anthracite nuts, and lignite briquettes, have shown that the first-named producer is the most economical. The fuel costs per h.p.-hour for the three types of generator are as follows:—

Anthracite nuts	**1·0437 Pf. (0·123d.)**
Anthracite dust	**0·3731 Pf. (0·044d.)**
Lignite briquettes	**0·7522 Pf. (0·09d.)**

In consequence of the usefulness of the gas produced for lighting by the Welsbach system, as well as for power purposes, the author prophesies a

great extension of the gas-producer industry in countries unprovided with water power, and in works far removed from any central installation of power-gas plant. The cost of anthracite nuts at the mine is 21 M. per ton, while anthracite dust costs only 7·0 M., and lignite briquettes 8·50 M. per ton.

J. B. C. K.

126. *Variation in Methods of Ignition for Petrol Engines.* **H. Topham** and **H. G. Tisdall.** (Engineering, 82. pp. 856–857, Dec. 28, 1906.)—This article describes some tests carried out upon a single-cylinder de Dion engine, with a cylinder 66 mm. diam., and 70 mm. stroke, in order to determine the relation of the consumption of petrol per b.h.p. of the engine to the character of the spark used for igniting the cylinder mixture. A dynamo was driven by a belt from the engine shaft to afford a load, and the various losses were allowed for in calculating the engine b.h.p. Tests 1 and 2 were made with accumulator ignition and no external spark-gap in the external circuit. In these circumstances the consumption of petrol per b.h.p.-hour was found to be 0·208 gall. during a 10-min. test, and 0·187 gall. during a 45-min. test. This reduction on a long run is attributed to a decrease in the engine friction as the different parts become warmed up. Two further tests, Nos. 4 and 5, with accumulator ignition and an external air-gap, gave consumptions of 0·226 and 0·24 gall. per b.h.p.-hour over runs of 18 min. Tests Nos. 3 and 6 with magneto-ignition gave 0·280 gall. of petrol per b.h.p.-hour over a run of 15 min., and 0·249 gall. over a run of 18 min. with external gaps in each case. In order to study the effect of the external spark-gap on firing, a high-resistance insulation-testing set was arranged so as to take almost instantaneous readings of the insulation resistance. It was found that this fell from over 1,000 megohms at starting to about 6 megohms after a run of 5 min., reaching less than 2 megohms when the plug had reached a dull red heat, obtained in this case in a control experiment with the heat from a methylated spirit lamp. At this point the spark diminished in intensity until it stopped entirely. The introduction of an external air-gap had the immediate effect of restoring the sparking between the points, although the experiment was pushed to such a degree that the insulation resistance dropped to 800,000 ohms, the plug being then at a bright red-heat. The authors therefore deduce that the leakage through the porcelain of the plug may become quite sufficient to entirely stop sparking in the cylinder when the plug becomes heated, the sparking-points being practically short-circuited. The effect of the external gap is to prevent the application of the voltage across the plug gap until the instant at which the current actually begins to flow in the high-tension circuit, the spark being then of the nature of a condenser discharge, and the leakage being considerably reduced in quantity. Experiments on the effect of speed on spark timing were carried out and are briefly described.

W. P. D.

AUTOMOBILISM.[1]

127. *Steam Plant of the White Motor Car.* **R. C. Carpenter.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 255–286, Nov., 1906. Automotor Journ. 11. pp. 1735–1739, Dec. 22, 1906. Eng. Rev. 16. pp. 42–50, Jan., 1907.)—Describes in detail the design and construction of the mechanism of these cars, the various parts being illustrated. The paper also contains detailed tests carried out by the author upon an engine rated at 30 h.p., with cylinders 3 in. × 4½ in.

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

and 6 in. × 4½ in. Trials were carried out at loads from ¼ to ¼ in excess of the rated load. An interesting digression discusses the specific heat of superheated steam, for which a varying value is allowed. The factor used is based on some interim results secured by C. C. Thomas at Sibley College, and is somewhat lower than that given by Callendar for low degrees of superheat, but essentially the same for high degrees. The paper concludes with a summary of the tests made by C. H. Benjamin [see Abstract No. 879 (1905)].
W. P. D.

REFERENCES.

128. *The Compound Reaction Steam Turbine.* (Engineering, 82. pp. 511–512, Oct. 19; 545–547, Oct. 26; 581–582, Nov. 2; 618–619, Nov. 9; 685–688, Nov. 23; 736–737, Nov. 30, and pp. 749–750, Dec. 7, 1906.)—The theory and design of such turbines is considered at great length, use being made of the most recent experimental results.

129. *Steam Turbines at the Nuremberg Exhibition,* 1906. **C. W. Gesell.** (Zeitschr. ges. Turbinenwesen, 3. pp. 425–435, Oct. 30, 1906.)—The chief exhibits of interest include a 50-h.p. locomobile with turbine combined and with mechanical stoker, and a 1,200-h.p. Sulzer steam turbine; illustrations and sectional drawings of these are given. [See also Zeitschr. Vereines Deutsch. Ing. 50. pp. 1567–1574, Sept. 29, and pp. 1788–1796, Nov. 3, 1906.]
L. H. W.

130. *Steam Turbine in Land and Marine Work.* **E. M. Speakman.** (Inst. Engin. and Shipbuilders, Trans. 50. 1. (pp. 12–49); Discussion, 50. 2. (pp. 2–16) and 50. 3. (pp. 1–10) 1906–7. Mech. Eng. 18. pp. 917–920, Dec. 29, and 19. pp. 2–5, Jan. 5, 1907. Abstract.)

131. *Governing of Multiple-stage Steam Turbines.* **H. Jansson.** (Zeitschr. ges. Turbinenwesen, 3. pp. 463–465, Nov. 20; 492–497, Dec. 10; 507–511, Dec. 20, and pp. 529–533, Dec. 29, 1906.)—A general discussion of the subject with special reference to the adaptation of turbine systems to ships. The different types of turbine are dealt with in the following order: (1) Pressure turbines with many pressure stages. (2 and 3) Pressure turbines with one pressure stage, many velocity stages and (*a*) only one wheel, (*b*) more than one wheel. (4) Pressure turbines with many pressure stages and velocity stages. (5) Pressure-excess turbines. Under these heads the Rateau, Zoelly, Elektra, Curtis, Parsons, and three types of Riedler-Stumpf turbines are treated. The obtaining of different power from the same turbine is also discussed. [See also Abstract No. 416 (1906).]
A. W.

132. *Erection of Large Steam Turbines.* (Eng. Record, 54. pp. 581–582, Nov. 24, 1906. From the "Sibley Journal.")—This article gives an account of the practical work of erecting two large steam turbo-generators, one of 5,500 kw. at the Williamsburg power-house in Brooklyn, and one of 5,000 kw. at the Gold Street power-house of the Brooklyn Edison Illuminating Co., under difficulties connected with the incomplete state of the buildings. The particulars are taken from a paper contributed by A. G. Christie. The turbines were constructed by the Allis-Chalmers Co., the one at Gold Street being furnished with a Harting regulator instead of the usual fly-ball and spring regulator fitted to Parsons turbines.
F. J. R.

133. *Steam-turbine Tests.* **T. Franklin.** (Electrical Times, 31. pp. 5–8, Jan. 3, 1907.)—This article gives practical suggestions about various points in turbine testing, dealing with leakage, effects of temperature, clearance spaces, friction load tests, by-pass valves, and reciprocating relay plungers. Methods of observing the behaviour of various parts of the turbine under steam test are indicated and illustrated by diagrams.
F. J. R.

134. *Graphical Calculation of Feed-water Heaters.* **N. A. Carle.** (Power, **26.** pp. 738–741, Dec., 1906.)—The author quotes formulæ for calculating the surface of heaters and Poole's for heat transmission [see Abstracts Nos. 758, 759, 1176 (1902), and 1191 (1905)] and then describes two charts designed to give direct readings of the amount of heating surface for the various conditions usually found in practice. One chart is constructed from average temperature calculations and the other by means of Poole's logarithmic formula. The two formulæ give practically identical results for initial temperatures of 40° and 60° F. and steam temperature of 212° F. Results differ materially for final temperatures below that point. F. J. R.

135. *Boiler Horse-power.* **N. A. Carle.** (Power, **26.** pp. 674–677, Nov., 1906.)—Instead of calculating by means of the actual evaporation multiplied by the "factor of evaporation" and dividing by 34·5 to get the boiler h.p., the author gives charts to show directly the number of lbs. of water required for 1 h.p. under ordinary conditions of temperature and pressure, and including the effect of superheated steam. Dividing the observed evaporation by this result gives the boiler h.p. Lines are drawn in the charts for a specific heat of superheated steam of both 0·48 and 0·60 so that the true result may lie between these. Two examples of the use of the charts conclude the paper. F. J. R.

136. *Deformation of Fire-tubes Subject to External Pressure.* **O. Knaudt.** (Zeitschr. Vereines Deutsch. Ing. **50.** pp. 1779–1788, Nov. 3, 1906.)—In this paper the author describes experiments on the amount of deviation from the cylindrical shape of various fire-tubes. Special attention is paid to tubes taken from boilers that have exploded, and curves are drawn to show the relation between pressure and deformation. The effect of temperature is also considered. [See also Abstract No. 3A (1907).] A. W.

137. *Johnston-Buddicom Epicyclic Gear.* (Automotor Journ. **11.** pp. 1692–1694, Dec. 15, 1906.)—An epicyclic gear which can be fitted to any car and in which the brake bands for changing the gears are operated by pneumatic cylinders supplied from pressure drums kept charged by means of the petrol engine. Fully illustrated. L. H. W

138. *Roller and Ball Bearings.* (Amer. Soc. Mech. Engin., Trans. **27.** pp. 420–506, 1906. Discussion. Abstracts of remarks in Mech. Eng. **18.** pp. 800–802, Dec. 8; 901–903, Dec. 29, 1906, and **19.** pp. 24–25, Jan. 5, 1907.)—A large amount of practical information is given in the paper, which, however, does not lend itself to abstracting.

139. *Power-gas Producers in Street and Interurban Railway Work.* **E. A. Ziffer.** (Street Rly. Journ. **28.** p. 479, Sept. 29, 1906. Abstract of paper read at the Milan Convention of the Internat. Street and Interurban Rly. Assoc., Sept. 29, 1906. Électricien, **32.** pp. 244–247, Oct. 20, 1906. Rev. Électrique, **6.** pp. 229–230, Oct. 30, 1906.)

140. *Power-gas Installations.* **R. Schöttler.** (Elektrotechn. Zeitschr. **27.** pp. 1105–1111, Nov. 29, and pp. 1134–1139, Dec. 6, 1906. Paper read before the Elektrotechn. Verein.)—A general article with illustrated descriptions of the better-known types of producers and engines.

141. *Regulations for Testing Gas Engines and Gas Generators.* (Zeitschr. Vereines Deutsch. Ing. **50.** pp. 1923–1928, Nov. 24, 1906.)—The regulations drawn up by the Verein in conjunction with the Verein deutscher Maschinenbau-Anstalten and the Verband von Grossgasmaschinenfabrikanten in 1906 are given, with explanations.

142. *Dirigible Balloon "Patrie."* (Locomotion Automobile, **14.** pp. 1–4, Jan. 5, 1907.)—Illustrated.

INDUSTRIAL ELECTRO-CHEMISTRY, GENERAL ELECTRICAL ENGINEERING, AND PROPERTIES AND TREATMENT OF MATERIALS.

143. *Ferric Chloride as Depolariser for Primary Cells.* (D. R.-P. 181,294. Centralblatt Accumulatoren, 8. p. 15, Jan. 20, 1907. Abstract.)—G. A. Wedekind mixes concentrated solution of ferric chloride with graphite and manganese dioxide, and compresses the mixture in bags of linen. The electrolyte consists of the chlorides of zinc, ammonium, and magnesium, and is brought to the consistency of dough by being mixed with gum arabic, containing arabic and metarabic acids, and finely ground bones. The depolariser bag is forced within the zinc cylinder into this dough, which latter prevents diffusion of the ferric chloride to the zinc. H. B.

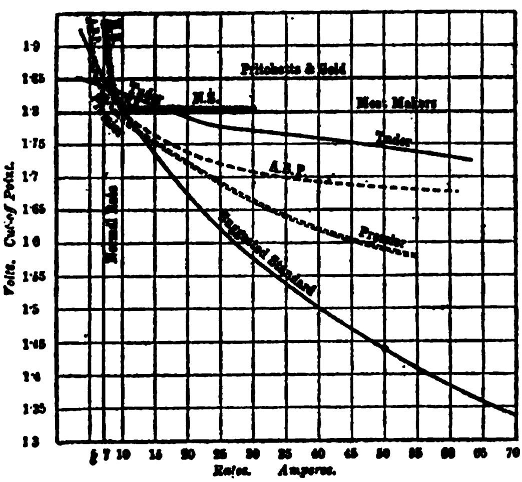
144. *Iron and Iron Oxide Electrodes for Alkali Accumulators.* (D. R.-P. 180,672. Centralblatt Accumulatoren, 8. pp. 17–18, Jan. 20, 1907. Abstract.) —T. A. Edison finds that chemically-prepared iron oxide is difficult to reduce electrolytically. He starts therefore from iron monosulphide, disintegrates it, mixes it with flakes of graphite, moistens the mixture with caustic potash of 20 per cent., and fills the material into the usual pockets. In these the material is electrolytically oxidised in caustic potash ; sulphur is to diffuse out as a potassium compound, and ferric hydrate to be formed ; to complete the removal of the sulphur, the current direction is periodically reversed. The negative electrode, to be combined with a nickel hydroxide electrode, is then ready for use. The proposals are criticised. H. B.

145. *Zinc-Nickel Accumulators.* (Centralblatt Accumulatoren, 8. pp. 13–14, Jan. 20, 1907.)—Comments on the cell of Polzeniuss and Goldschmidt [see Abstract No. 18 (1907)]. Referring to the researches, of 1901, of Michalowski and Laszczynski, it is pointed out that zinc might also be precipitated from a solution of borofluoric acid, which conducts better than fluosilicate. It would further be possible to reduce a porous zinc from a paste of zinc oxide and zinc chloride, or to use pockets, the conductivity being increased by adding graphite, mercury, scales of nickel, &c. Potassium carbonate of density 1·3 seems to be the best electrolyte for such cells. H. B.

146. *The "Allotropic Lead" Accumulator.* (Centralblatt Accumulatoren, 7. pp. 305–308, Dec. 20, 1906.)—The conclusions of Rosset as to the actions in this cell are disputed, and the validity of the tests attacked [see Abstract No. 785 (1905)]. It is pointed out that more acid was used than would be employed in an actual traction cell ; that acid was filled in during the test, and, most important, no data as to temperature were given. If this was 40° C. the actual capacity, reduced to 20°, would only be 29·3 watt-hours per kg. of cell. Tests were made with a 13-plate E.I.t. cell of total weight 8·315 kg. filled with acid of 34° Bé. On the 28th discharge (to 1·70 volts) a mean p.d. of 1·921 was obtained, lower than Rosset's value. The output at 27° C. was 228 watt-hours or 27·4 watt-hours per kg. of cell; this reduced to 20° gives 25·65 watt-hours per kg. The amp.-hour and watt-hour efficiencies were 98·1 and 78·5 per cent. respectively. Simultaneous tests of two ordinary German traction cells with high acid density (1·28 and

1·25 when charged) are then described which tend to show that in all points claimed—watt-hours per kg., mean p.d., and p.d. to cadminum electrode—the values obtained with the ordinary lead cell are superior to those with the "allotropic lead" cell. L. H. W.

147. *Recent Storage Battery Improvements.* **S. Cowper-Coles.** (Electrician, 58. pp. 183–185, Nov. 9, and pp. 169–170, Nov. 16, 1906. Abstract of paper read before the Soc. of Engineers, Nov. 5, 1906. Elect. Engin. 38. pp. 660–664, Nov. 9; 704–706, Nov. 16, and pp. 784–787, Nov. 23, 1906. Elect. Rev., N.Y. 49. pp. 858–861, Nov. 24, and pp. 884–888, Dec. 1, 1906. Centralblatt Accumulatoren, 7. pp. 301–302, Dec. 5, 1906.)—After touching upon the Edison cell, the different types of plates used in lead cells, thermoelectric and concentration effects, the author deals with the question of cut-off points in discharge. It is pointed out that the limits given by makers are generally arbitrary, and vary a great deal with the rate. There is, however, uniformity on the part of makers in taking 1·85 volts per cell as a



CUT-OFF POINTS FOR 70-A.H. CELL. BASED ON CONSTANT-CURRENT DISCHARGES.

limit on a 10-hour rate. The author therefore takes this figure as a basis, and determines whether the discharge has gone far enough at any higher rate by reducing the current for a short time to a value equal to the 10-hour rate; if, after a few seconds, the p.d. per cell is as low as 1·85 volts, the discharge is considered at an end. Based on experiments of this kind, a curve is given showing the point of cut-off for any discharge rate (see Fig., in which the other curves show the limits allowed by various makers). After dealing with the importance of porosity in plates, and the actions which take place, the author goes on to cells of the solid type, such as the N.S. cell [Abstract No. 61 (1904)], and describes more particularly the "Panthode" cell, in which a network is built up of material such as pumice, and is then coated with a film of active matter. **E. Lyndon.** (Elect. Rev., N.Y. 50. pp. 29–30, Jan. 5, 1907.)—A criticism. W. R. C.

148. *Electrolytic Production of White Lead.* (U.S. Pat. 836,177. Electrochem. Ind., N.Y. 4. p. 505, Dec., 1906. Abstract.)—In E. D. Chaplin's arrangement the middle compartment of the three-part cell is charged with a mixture of

sodium nitrate and sodium chloride. In the anode compartment the lead anodes are dissolved to acid oxychloride without formation of insoluble basic salts, in the kathode compartment (copper electrodes) caustic soda is formed. In another tank the soda and oxychloride are mixed and lead hydrate is precipitated. Part of the caustic is treated with CO_2, and the bicarbonate used for precipitating, in yet another tank, a superior white lead. The process is continuous, and the materials consumed are lead, CO_2, and the salts. H. B.

149. *Preparation of Iron for Galvanic Deposition.* (D.R.-P. 175,986. Zeitschr. Elektrochem. 13. pp. 4–5, Jan. 4, 1907. Abstract.)—J. Schiele first makes the iron object (plate) to be galvanised for a short time anode in a mixture of. hydrochloric and nitric acids of from 10° to 20° Bé., against a carbon kathode of much larger surface; the current density is 20 amps. per dm^2. The black film having been wiped off, the plate appears bright and porous. The plate is at once electrolytically covered with a film of the respective metal in a bath containing only this metal as anode, but not as salt in solution; the current density at the anode should be smaller than at the kathode. Then follows the electrodeposition proper. The deposits thus obtained adhere very well. H. B.

150. *Molybdenum from Molybdenite.* (U.S. Pat. 835,052. Electrochem. Ind., N.Y. 4. p. 503, Dec., 1906. Abstract.)—F. M. Becket heats molybdenite, MoS_2, with carbon and an oxide or carbonate of an alkali or alkaline earth in an electric furnace. The reaction is: $2MoS_2 + 2CaCO_3 + 5C = 2Mo + 2CaS + CS_2 + 6CO$; the same products result when CaO is used instead of the carbonate. As a modification the use of calcium carbide is proposed: $5MoS_2 + 2CaC_2 = 5Mo + 2CaS + 4CS_2$. The resulting molybdenum is free from oxide, and contains not more than 0·2 per cent. of carbon. Alloys are produced by introducing metallic nickel, iron, &c., into the charge. H. B.

151. *Rotating Electric Steel Furnace in the Artillery Construction Works at Turin.* **E. Stassano.** (Faraday Soc., Trans. 2. pp. 150–151; Discussion, pp. 151–155, Dec., 1906. Elect. Engin. 37. p. 521, April 13, 1906. Chem. News, 93. p. 221; with Discussion, May 11, 1906. Abstract. Elektrochem. Zeitschr. 13. pp. 60–61, June, 1906.)—The furnace is principally used for refining pig-iron and smelting scrap, and absorbs 140 kw. electric energy between the electrodes, the current being a three-phase one with 80 volts between each phase. The charge usually consists of 200 kg. pig-iron turnings, ore and lime, 200–300 kg. iron and steel turnings, 100–200 kg. iron and steel scraps, and an ordinary proportion of ferro-silicon and ferro-manganese. The consumption of electrical energy per kg. of steel produced is, for 200-h.p. furnaces, 1 kw.-hour, and for furnaces of 1,000 h.p., now under construction, will be even less. The loss of electrodes is always under 5 kg. per ton of steel, which is considerably below that in Héroult's furnace. The refractory covering of the furnace requires renewal about once a month, which costs some 10 francs per ton of metal made. The yield per 24 hours is 2,400 kg. [See also Abstract No. 1040 (1906).] W. H. Sı.

152. *Electrothermics of Iron and Steel.* **C. A. Keller.** (Faraday Soc., Trans. 2. pp. 36–40; Discussion, pp. 40–43, Aug., 1906. Chem. News, 93. pp. 220–221, May 11, 1906. Abstract with Discussion.)—Electric furnaces for the industrial production of iron and steel are now installed at Unieux and

Livet, France. In the first-mentioned the current is used exclusively as a deoxidising, refining, and reheating agent, and is generated by a Westinghouse alternator driven by a Dujardin steam engine of 1,500 h.p., by which up to 20,000 amps. can be obtained. The furnace, weighing about 50,000 kg., rests on a steel cradle and can be tilted, and some 8,000 kg. of metal can be operated upon at one time. At Livet the furnace is of 2,000 h.p., and will produce about 20 tons of metal in 24 hours. Its current strength is 25,000 amps. By means of the Keller electric furnace, which may be regarded as a quick-process blast furnace, the sulphur is readily eliminated, and the proportion of C and Si may be varied at will, the latter between the limits 0·9 and 8 per cent. This should prove of great utility in the production of metal to be used for softening and for special castings. In the *discussion*, **Morrison** stated that he had used an electric furnace with a current as high as 82,000 amps.; **Harbord** considered blast furnaces, when economically worked, by far the cheapest mode of production, and that the practice of varying the quantity of Si in a casting by varying the amount of silica in the pig-iron, and mixing them in the cupola, was quite satisfactory; and **Huntingdon** referred to some experiments made by himself in conjunction with Siemens in 1882 on the amounts of C and Si pig-iron will take up, in which the range found for Si was 0·25 to 9 per cent. The **Author**, in reply to Morrison, stated that the use of the central electrode had proved perfectly satisfactory, it being possible to keep the metal in the central canal fluid. W. H. Si.

153. *Soft Graphite.* (U.S. Pat. 836,355. Electrochem. Ind., N.Y. 4. p. 502, Dec., 1906. Abstract.)—E. G. Acheson prepares a soft unctuous graphite, suitable for lubrication, electrotyping, &c., by heating in an electric furnace carbonaceous matter, coal or coke, with some carbide-forming material, the latter not sufficient in quantity for the theoretical production of carbide, but more than is contained in the natural ash of the coal. In an electric furnace, 18 ft. in length, a mixture of coal and sand is packed round a core of graphite, a rod ⅞ in. diam. The mixture consists of 65 parts of ground anthracite and 35 of sand and coal, the coal ash being calculated as sand. Surrounding this active zone of 18 in. diam. is a layer of 1 part of coal and 2 parts of sand, which serves as heat-retainer. The current, started at 79 volts and 75 kw., rises to 208 volts and 200 kw. after 2 hours, and to 135 volts and 800 kw. after 9 hours; after 15 hours, 70 volts and 800 kw. were observed. The 962 lbs. of soft graphite obtained do not coalesce under pressure. Sand is preferable to oxides, which form fluid carbides. H. B.

154. *Oxidation of Atmospheric Nitrogen.* **K. Birkeland.** (Faraday Soc., Trans. 2. pp. 98–116; Discussion, pp. 116–119, Dec., 1906. Electrician, 57. pp. 494–500, July 13, 1906. Abstract. Chem. News, 94. p. 35; with Discussion, July 20, 1906.)—Further details are given of the Birkeland-Eyde process [see Abstracts Nos. 422 and 566 (1906)]. Water-cooled electrodes of copper tubing of 15 mm. diam. are employed at a distance apart of 8 mm. Between them is established an alternating arc with 5,000 volts at 50 ∿ in a direct magnetic field of 4,000–5,000 gauss. With too high magnetisation, or if the electrodes are too near together, the oscillograph curves show that several hundred arcs may be produced per sec., but as a rule, with steadily burning flames, only 1 arc per sec. The electrodes are exchanged and repaired after a run of 300 hours at 500 kw. The power-factor is 0·7. With the working potential of 5,000 volts, 8,500 volts and over are obtained at the electrodes. The furnaces are lined with firebrick, which does not attain a higher tem-

perature than 700° C. In the new factory at Notodden it is decided that the furnaces shall work at 750–850 kw. They will be supplied with 30,000 h.p. Details are given of the method of condensation of the nitrogen products and the production of the basic calcium nitrate. The question of plant and working costs is discussed. The second part of the paper deals with the theory of the oxidation of nitrogen, and experimental investigations made in confirmation. A small high-tension flame arc was examined. It was produced by spreading out the discharges from a large induction coil with mercury interrupter into a disc in a magnetic field. A faintly illuminating, violet disc-flame was thus produced, more or less semicircular, and of about 6 cm. diam. The flame was about $\frac{1}{10}$ mm. thick. These and other experiments show that even with flames of great energy the arcs *issue from the electrodes as fine arc threads.* By taking instantaneous photographs of the flames it is found that the positive arc-prints consist of continuous bands of about 0·5 mm. in width, whilst the negative arc-prints consist chiefly of very close, round spots, about 0·6 mm. diam. Probably carriers of different kinds carry the negative electricity into the flame from the small hot spots on the negative electrodes. The negative ions may start as electrons and gradually get loaded by molecules condensing round them. The number of molecules that are split up into ions in the arc is estimated, and the result is compared with the action of radium. The effect of the arc in producing NO is also studied with reference to the laws of thermo-chemistry, and the equation of Nernst is applied.

W. W. H. G.

155. *Synthetical Preparation of Ammonia by the Dark Discharge.* (D.R.-P. 179,300. Zeitschr. Elektrochem. 13. p. 12, Jan. 11, 1907. Abstract.)—The Westdeutsche Thomasphosphat-Werk Gesell. pass the discharge through Dowson gas containing about 14 per cent. by vol. of H, 43 of N, 39 of CO, and 4 of CO_2. Mixtures of H and N combine readily to NH_3 under the influence of the dark discharge; but Berthelot failed with industrial gas mixtures, which gave neither NH_3 nor NH_4-salts, but apparently polymers of formamide, $(HCONH_2)n$. When the gas is cooled down to 65°, or at least 80° C., however, discharges of 15,000 volts and 2 or 2·5 amps. convert 20 per cent. of the nitrogen, that is, 8 parts by volume of the mixture, into NH_3. H. B.

156. *Magnetic Concentration and Briquetting of Iron Ores.* (Electrochem. Ind., N.Y. 4. pp. 510–511, Dec., 1906.)—A description of the Gröndel process, the American patents for which are held by the American Gröndel-Kjellin Co. of New York. The crushing and concentrating process is commercially applicable to poor magnetite containing down to 25 per cent. of iron, as well as to magnetite containing a high percentage of phosphorus and copper not chemically combined with the iron. The crude ore is reduced to about ½-in. cubes in a crusher, and is then treated with water in a Gröndel ball mill, from which it escapes as a pulp. Each mill requires 20 to 25 h.p., and treats 50 to 100 tons of ore per day of 24 hours. The ore thus crushed is then passed through a magnetic separator; if much slime be present, the pulp is first passed through a slime-box. The design and action of the slime-box and of the magnetic separator cannot be properly understood without the illustrations, but in each portion of the apparatus use is made of a strong magnetic field for separation of the magnetite from the other constituents of the raw ore. The final separation is into pure magnetite, middlings, and tailings, and recent trials with a new form of drum separator at Herrang have given the following results: Concentrates, 60 to 61·5 per cent. Fe; middlings, 7 to

10 per cent. Fe; tailings, 5 to 8 per cent. Fe. The capacity of a double drum separator is 70 to 100 tons of ore per day of 24 hours, and it requires only 6 amps. at 120 volts, or 1 e.h.p., for the pole-pieces of the magnetic field, and ¼ e.h.p. for driving the drums [see Abstract No. 1617 (1905)]. The concentrates obtained by the above method are next formed into briquettes of suitable size, without the use of any binding material, by the Gröndel process, the moisture in the briquettes as moulded being so adjusted as to hold the briquettes together until dried at a temperature of 1,400° C., when the particles agglutinate, to form a hard briquette. The briquettes travel upon specially designed cars through the gas-fired drying furnace in a contrary direction to the hot gases. The consumption of coal is only 7 per cent. of the weight of the briquettes dried. The output of one such furnace varies from 80 to 100 tons per 24 hours. The following are tests of the ore before and after concentration and briquetting:—

	Iron.	Sulphur.	Phosphorus.
Crude ore	89·8 per cent.	1·18 per cent.	0·006 per cent.
Concentrates	62·9 ,,	0·27 ,,	0·008 ,,
Refuse	11·4 ,,	1·58 ,,	0·017 ,,
Briquettes	61·1 ,,	0·008 ,,	0·008 ,,
Pig-iron from briquettes ...	—	0·005 ,,	0·012 ,,

These results were obtained at Herrang, in Sweden. J. B. C. K.

157. *Electric Welding Apparatus.* (Elektrotechnik u. Maschinenbau, 24. p. 1074, Dec. 30, 1906.)—W. Egel, of Berlin, has patented an apparatus for electrically welding thin iron plates (Austrian Pat. 24,335), consisting of two easily replaceable roller electrodes, the upper of which is mounted on a spindle and driven by a hand-wheel. A bevel-wheel is fitted to the other end of the spindle to allow for driving mechanically. The fork carrying the upper electrode is extended to form a rack, into which a pinion is geared for the purpose of moving the electrode closer to or away from the lower electrode by means of a hand lever. The plates to be welded, which may be very thin, are placed between the roller electrodes and are continuously welded by the pressure between the upper and lower electrodes. An apparatus for electrically welding spiral tubes, made by the Fabrik Elektrischer Schweissungen, of Szepesvaralja (Hungary), consists of four rollers, two of copper and two of steel (Austrian Pat. 25,989). The metal strip of suitable width is bevelled on the edges to be welded, and after being passed through a rolling machine, the edges are introduced between the copper rollers and immediately afterwards between the steel rollers. The four rollers are so arranged that the tube is wound into a spiral with the bevelled edges overlapping. The copper rollers are connected to an electric circuit, causing the edges of the strip to be raised to a welding heat. The strip immediately passing between the steel rollers, the edges are rolled to the thickness of the walls of the tube, and the welding is continuous. The same firm have also devised a machine for welding together tubes at any desired angle (Austrian Pat. 25,948). The main tube and branch, after being cut at the joint in the required manner, are each mounted in a special clamp, the clamp carrying the branch tube being movable towards that carrying the main tube by means of a screw and hand-wheel. The clamps being connected to an electric circuit, the tubes are welded by pressure as usual. In order to weld pieces of tube at any desired angle, the carriers for the clamps are fixed in adjustable bearings.

R. J. W.-J.

158. *Strobograph.* **G. Wagner.** (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1981–1987, Dec. 8, 1906. Extract from Mitteil. über Forschungsarbeiten, No. 88.)—A hollow cylinder, with a number of rectangular holes at regular intervals along its periphery, is mounted on the axle of the machine whose speed or speed-variation is to be measured. The cylinder can be illuminated internally. A disc with radial slits, driven by an electric motor, whose speed can be finely regulated by means of an adjustable resistance, is mounted on a shaft at right angles to the axle of the machine, and is arranged so that the light coming through the holes in the cylinder is viewed through the slits in the rotating disc. A camera is placed behind the disc, and after the speed of the motor has been adjusted properly, a photograph of the holes, viewed through the slits, is taken. Diagrams are given for a gas engine, and it is shown how from the diagrams the speed during the various portions of the stroke, *e.g.*, during compression or explosion, can be calculated. A. W.

159. *Temperature Compensation for Induction Instruments.* (Engineering, 83. p. 99, Jan. 18, 1907.)—Alternate-current instruments acting on the induction principle, such as those in which a metal disc is deflected against a spring by the couple exerted on it by a shaded-pole electromagnet, are subject to errors due to change of frequency and change of temperature. In the case of voltmeters, the frequency error may be rendered negligible for a range of from 25 ∾ to 100 ∾ by adjusting the resistance and reactance of the winding so that with increase of frequency the current decreases, the torque remaining thereby unaltered. In Brit. Pat. 27,175 of 1906, C. C. Garrard and Ferranti, Ltd., describe a device whereby the temperature error of such instruments may be compensated by the use of an automatically varying reactance. Connected in series with the shaded-pole magnet coil is a reactance coil whose magnetic circuit includes an air-gap. This air-gap may be bridged to a greater or less extent by a movable core attached to a compound strip made up of metals having different temperature coefficients, and so arranged that as the temperature rises the reactance is decreased, allowing more current to flow through the instrument, and thus counteracting the effect due to the increased resistivity of the movable disc. A. H.

160. *Differential Electrodynamometer.* **H. Tellier.** (Ind. Élect. 16. pp. 29–32, Jan. 25, 1907.)—The method first described by Potier of using a differential electrodynamometer having two fixed coils and one movable coil to measure the power expended in an alternating-current circuit is described. In constructing the instrument the assumption was first made that the fixed coils acted as if they were circular in shape, and thus the dimensions of the spring required were found with sufficient accuracy. Then by measurement with direct currents the true constant of the instrument was found. The spring employed was helical, the cross-section of the wire being circular. Hence if G be the torque required to produce a deflection of 360°, we have $G = (3\pi/32)E(d^4/l)$, where E is the modulus of elasticity, d the diam. of the circular section, and l the length of the spring. It is absolutely necessary that the spring be perfectly centred if the readings of the pointer of the torsion head are required to be very accurate. Commercial wattmeters were standardised by this instrument on circuits with e.m.f.'s and currents of very distorted wave-shapes. It was found that the Siemens wattmeter gave practically exact readings whatever the shape of the waves or the power-factor of the load. A. R.

161. *Compound Dielectrics.* **G. Benischke.** (Elektrotechn. Zeitschr. 28. pp. 95–97, Jan. 31, 1907.)—If a plate of dielectric is made up of two plates of materials having different dielectric constants, then for a given p.d. across the plate the electric intensity in the material of smaller dielectric constant is greater than in the other. The dielectric strength of such a compound plate is greater than that of a plate of uniform material throughout. This result is utilised by the A.E.G. Co. in certain cases, compound insulating cylinders of porcelain and micanite being employed, the one cylinder being placed within the other. In high-voltage oil switches the leading-in tubes consist of porcelain cylinders set in bushes of stabilit. In order to obtain a more uniform potential gradient in the insulating covering of a cable, the innermost layer of the insulation should have a larger dielectric constant than the outer layers. Should one of the plates forming a compound dielectric slab have an appreciable conductivity the total dielectric strength is weakened, since the entire p.d. will then have to be borne by the other plate. A. H.

162. *Temperature-coefficient of Gutta-percha.* **K. Winnertz.** (Elektrotechn. Zeitschr. 27. pp. 1115–1117, Nov. 29, 1906. Electrician, 58. p. 458, Jan. 4, 1907. Translation.)—The author claims to have obtained more exact

Temp. C.	Coefficient.	Temp. C.	Coefficient.	Temp. C.	Coefficient.	Temp. C.	Coefficient.
35·0	0·1415	26·1	0·7066	17·2	2·790	8·3	7·943
34·4	0·1561	25·6	0·7707	16·7	3·035	7·8	8·178
33·9	0·1721	25·0	0·8406	16·1	3·302	7·2	8·338
33·3	0·1898	24·4	?	15·6	3·588	6·7	8·499
32·8	0·2105	23·9	1·0000	15·0	3·896	6·1	8·585
32·2	0·2332	23·3	1·089	14·4	4·223	5·6	8·637
31·7	0·2574	22·8	1·187	13·9	4·564	5·0	8·678
31·1	0·2836	22·2	1·293	13·3	4·919	4·4	8·719
30·6	0·3125	21·7	1·409	12·8	5·282	3·9	8·757
30·0	0·3442	21·1	1·535	12·2	5·650	3·3	8·796
29·4	0·3838	20·6	1·672	11·7	6·015	2·8	8·834
28·9	0·4304	20·0	1·821	11·1	6·378	2·2	8·880
28·3	0·4801	19·4	1·984	10·6	6·722	1·7	8·932
27·8	0·5251	18·9	2·161	10·0	7·057	1·1	8·990
27·2	0·5848	18·3	2·353	9·4	7·377	0·6	9·053
26·7	0·6458	17·8	2·562	8·9	7·670		

results than have hitherto been accepted. These are shown in the table above. E. O. W.

163. *Polyphase Power Measurements.* **C. A. Adams.** (Electrical World, 49. pp. 143–144, Jan. 19, 1907. Paper read before the Amer. Assoc. for Advancement of Science, Dec. 27, 1906.)—The author shows that the proof of the methods for the measurement of power on polyphase circuits is exceedingly simple. It may be stated as follows: In any $n-1$ wire system (direct current or alternating current, balanced or unbalanced), assume one wire as a common return for the other $n-1$ wires, considered as carrying the outgoing currents of the $n-1$ separate circuits; and connect $n-1$ wattmeters as if to measure the power expended in these $n-1$ separate circuits. Then the algebraic sum of the readings of the $n-1$ wattmeters will

be the total power of the system. Most of the text-books employ algebraic or graphic proofs which apply only to particular arrangements of circuits.

A. R.

164. *New Low-hysteresis Steel Alloy.* (Elect. Rev. 60. p. 96, Jan. 18, 1907.)—A few particulars are given of a new patented alloy introduced by J. Sankey and Sons, and called by them "Stalloy." The hysteretic and eddy-current losses in this metal are reduced much below those in the firm's own "Lohys" brand. Fig. 1 shows the average (watts per lb.) loss in sheets of 0·014 in. thickness (about No. 28 S.W.G.) at 50 ∿ and various inductions.

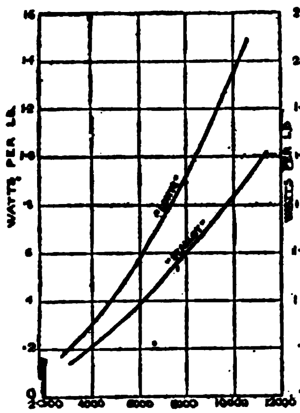


Fig. 1.

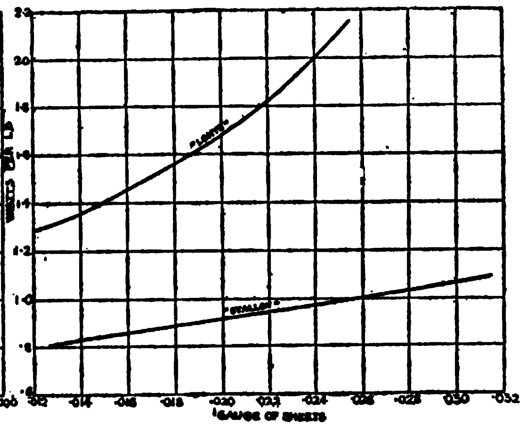


Fig. 2.

Fig. 2 gives the watts lost per lb. (at B = 10,000 and 50 ∿) for sheets from 0·012 to 0·032 in. in thickness, the improvement being still more marked with the thicker sheets. The loss at 100 ∿ and B = 4,000 is only 0·2 watt per lb. with the new steel as against 0·4 watt for "Lohys" steel. Thicker sheets can thus be employed for the same loss, and the labour of handling and stamping is reduced, as well as the space wasted with insulating material.

L. H. W.

165. *Hard-drawn Copper Wire.* T. Bolton. (Elect. Rev. 60. pp. 131–133, Jan. 25, 1907.)—The Engineering Standards Committee defined hard-drawn copper wire as that which will not elongate more than 1 per cent. without fracture. The author points out that with hard-drawn wire the elongation under longitudinal stress is more or less local, and that in this respect hard-drawn wire differs from soft annealed wire. Hence, in the case of hard-drawn wire, the percentage elongation is a function of the length and of the diameter of the specimen; and the modulus of elasticity is similarly a function of that length. Engineers are therefore recommended by the author to specify separately the properties of each size of wire, accepting the breaking stress as the most trustworthy basis. As the result of actual tests, a table of proposed standards is constructed for a wide range of diameters. In addition, a series of curves is given, co-ordinating: (1) Elongation and load, for two sizes of hard-drawn wire, where there has been no intermediate annealing in the drawing process. (2) Elongation and load for seven sizes of hard-drawn wire prepared as for ordinary requirements. (3) Breaking load and sectional area. The table of proposed standards includes the resistance per mile of

various sizes of hard-drawn copper wire. [These resistances correspond to about 98·2 per cent. conductivity on Matthiessen's standard; they differ therefore from the values suggested by the Engineering Standards Committee, which work out at almost exactly 98 per cent. on Matthiessen's basis.] R. A.

166. *Phase-differences and Transformer Measurements.* **L. W. Wild.** (Electrician, 58. pp. 263–264, Nov. 30, 1906.)—The author thinks that the results of the tests made by Drysdale on a transformer [see Abstract No. 1410 (1906)] may mislead instrument makers, as the transformer is of poor design. He states that only one-half of the winding space is available, that thinner iron stampings should have been used, and that the magnetic qualities of the iron must be poor at low induction densities. In the transformer experimented on by Drysdale the difference between the effective ratios and the winding ratios is never less than 1·2 per cent. The author using a transformer of 1/8 the weight, reduced this ratio down to 0·4 per cent. at a frequency of 50 and 0·2 per cent. at a frequency of 100. He criticises Drysdale's rule that current-transformers should be worked at as low an induction density as possible, and therefore that they should be heavy. He points out that the reduction of the core losses and magnetising current by no means compensates for the increase of weight and cost. A comparison is given of two transformers working on short-circuit, the linear dimensions of which are in the ratio of 1 to 2. It is concluded that increasing the weight 8 times reduces the core loss to 1/2 and the magnetising component to 1/2 of its former value. For ammeters and voltmeters the magnetising component is of little consequence, provided that the magnetic leakage and the self-inductance of the instrument are negligible. When wattmeters are to be used on low power-factors, however, the magnetising current is of much greater importance than the core-loss current. **C. V. Drysdale.** (Ibid., pp. 341–342, Dec. 14.)—In reply Drysdale admits that the winding space in his transformer was not fully utilised, but points out that in the ratio transformers used on high-tension circuits the space-factor has frequently the same value as in his transformer. He made a series of tests with the best possible arrangement of the winding coils and found that the ratio was about 1 per cent. less than that of the number of turns. He points out the extreme difficulty of finding this ratio accurately, especially when it is a large number. The iron used was "Lohys," of the usual transformer thickness (14·7 mils). **L. W. Wild, C. C. Garrard.** (Ibid., pp. 424–425, Dec. 28.)—Wild describes the method he employs for finding the ratio of transformation, but admits that the testing of series transformers is difficult. C. C. Garrard states that in the transformers he designs he has always found that, within the limits of experimental error, the ratio of transformation equals the ratio of the turns on the primary and secondary. He also states that a large magnetising current has a greater effect on the transformation ratio than a large core loss. The effect of the magnetising current is especially serious in a three-phase wattmeter. [Further correspondence appears in subsequent issues.] A. R.

167. *Potential Surges and a New Form of Lightning-arrester.* **R. P. Jackson.** (Amer. Inst. Elect. Engin., Proc. 25. pp. 843–862, Dec., 1906.)—By the use of a hydraulic analogy the author explains in a simple manner the action of lightning-arresters. The effect of surges in breaking down transformer windings and circuit-breaker bushings is then dealt with and compared

to the action of a water-hammer. The steepness of an advancing wave-front of high potential may be reduced, and so the insulation stress on the first few turns of the transformer or generator winding reduced, by the interposition of a choking coil, which causes a partial reflection of the high-potential wave. On considering the actual values of the minimum inductance of the choking coil required to give adequate protection, the author finds that such protection becomes impossible in the case of 60-cycle circuits of low voltage and power-factor and conveying large currents, owing to the excessive drop in the choking coil under normal working conditions. Of the two forms of lightning-arrester mostly used—viz., the horn type and the multi-gap non-arcing type—the author prefers the latter in cases where a very large amount of power is being transmitted, as the arc is suppressed with a much lower resistance in series with the arrester than in the case of the horn type. Thus it was found that, with a voltage to earth of 88,000 on a three-phase 7,500-kw. plant, 800 ohms were sufficient to suppress the arc when a multi-gap non-arcing arrester was employed, whereas a horn arrester required a series resistance of 1,000 ohms for its proper operation. Practical experience with multi-gap arresters has shown that the operating voltage depends very largely on the presence or absence of neighbouring conductors. For instance, an arrester which acted at 75,000 volts, when placed in the open or away from the ground or walls, was found to spark over at 40,000 volts when placed near the ground and mounted between cement barriers. This may be accounted for by the unequal distribution of the potential stresses over the various gaps, the potential gradient being increased on the line side and reduced on the earth side. A metallic shield near the line end of the gaps and connected to the line will equalise the potential gradient across the gaps and reduce the breakdown voltage to its normal value. A peculiar effect has been noticed in connection with the behaviour of different forms of series resistances; this effect was investigated by discharging a large condenser, previously charged to 50,000 volts, through the resistance under test, and measuring the "equivalent spark-gap" by means of a gap shunting the resistance. It was found that in the case of electrolytic and metallic resistances, paralleling two resistances halved the equivalent gap, while connecting them in series doubled it. But in the case of carbon, carborundum, and graphite, the equivalent gap was found to be the same for a single bar as for several of them connected in parallel, while for a bar of varying length it was found to be a complicated function of the length. Instead of series resistances, it may in some cases be desirable to use a fuse, which should be either of the enclosed or the expulsion type. The author finally describes a new form of arrester, termed by him an *electrolytic arrester*, which is stated to be absolutely sudden in its action when any abnormal rise of voltage takes place. It consists simply of an aluminium electrolytic cell connected in series with a suitable gap between each line wire and the earth—either a multi-gap or a horn-gap may be used. The equivalent spark-gap of such a cell is a function of its dimensions, and it is a simple matter to construct a unit for a 10,000-volt circuit which will have an equivalent gap corresponding to 12,500 volts. The author concludes by saying that many mechanical difficulties presented themselves in making such cells for commercial use; most of these have now been overcome, but the cell is being subjected to further tests. A. H.

168. *High-voltage Insulators.* **O. Prohaska.** (Elekt. Runds. 23. pp. 562–566, Dec. 27, 1906.)—The author enumerates the conditions which should be satisfied by a good high-voltage insulator, describes some recent insulators of

American make, and compares with them the "delta" insulator made by the Hermsdorf porcelain works. This insulator is made in one piece (the larger sizes in two parts cemented together), and is provided with a complete series of umbrella-shaped expansions so arranged that, while the insulator surface is sufficiently shielded against a driving rain, all parts of it are freely exposed to light and wind, so that it does not attract insects. The insulators are tested with a voltage which is from two to three times their normal working voltage, both for dielectric strength and for brush discharge in a heavy shower. The author states that, as regards insulators, there should be no difficulty about using voltages in excess of any so far tried. A. H.

REFERENCES.

169. *Metals and their Ferro-Alloys used in the Manufacture of Alloy Steels.* **O. J. Steinhart.** (Inst. Mining and Metallurgy, Trans. 15. pp. 1–25, 1905–1906. Excerpt.)—The author gives statistics and concise information, partly from actual manufacturing experience, concerning the ores, their occurrences, the chief companies interested in them, their metallurgical processes, costs of production, and the applications of the following metals and alloys: Nickel and ferro-nickel, chrome and ferro-chrome, tungsten and ferro-tungsten, molybdenum and vanadium and their ferro-metals. Electrolytic and electrothermic processes are also mentioned. H. B.

170. *Three-phase Power Measurement.* **H. M. Scheibe.** (Elect. Journ. 4. pp. 56–57, Jan., 1907.)—An extremely simple and very elegant explanation of the well-known two-wattmeter method of power measurement. A. H.

171. *Power Measurements in Alternate-current Circuits.* (Elektrotechnik u. Maschinenbau, 25. pp. 12–16, Jan. 6, 1907.)—The problem of power measurement is dealt with in a very general way in the case of a multiple-wire conducting network, and the various known methods applicable to a three-wire or three-phase system are then considered in detail. A. H.

172. *Some Points in Alternating-current Theory.* **L. Lichtenstein.** (Dingler's Polytechn. Journ. 321. pp. 38, 109, and 118. Elektrotechn. Zeitschr. 28. pp. 34–35, Jan. 10, 1907.)—A paper in which the author criticises various common errors, notably that in which the p.d. across the ends of a conductor—such as a length of rail—conveying an alternating current is regarded as having a definite value, without any reference to the arrangement of the remaining part of the circuit. A. H.

173. *Speed Recorder for Dynamos and Motors.* (West. Electn. 39. p. 478, Dec. 15, 1906.)—When running alternators in parallel, it is often difficult to determine whether the irregularities are due to the engine or to phase swinging of the alternators. This instrument is intended for use in such cases. The record obtained by a series of sparks which perforate a moving band of paper enable the instantaneous values of the angular velocities of the various machines to be found. The device has been developed in France. A. R.

174. *Single-phase Crane Equipment.* (Electrical World, 49. pp. 141-142, Jan. 19, 1907.)—A brief description of the electrically-driven cranes at the Cologne-Deutz dock, which are fitted with Winter-Eichberg motors for lifting, slewing, and travelling. The supply p.d. is 500 volts, and the frequency 50. The lifting motor is a 40-h.p., 10-pole one, and the travelling and slewing ones are 10-h.p., 6-pole. Control is effected by varying the secondary turns. The exciting current is led directly into the armature, without the interposition of any transformer. A. H.

GENERATORS, MOTORS, AND TRANSFORMERS.

175. *Use of Oscillograms in Connection with Inter-pole Machines.* **J. N. Dodd.** (Elect. Journ. 3. pp. 581–584, Sept., 1906.)—The writer has investigated the flux distribution in a dynamo fitted with commutating poles by means of an oscillograph connected to two adjacent commutator bars. The condition for sparkless running is that the voltage of the coil when undergoing short-circuit should vanish. There will in this case be a portion of the oscillogram coinciding with the zero line. If no such portion exists, the oscillogram crossing the zero line sharply, sparking will take place to a greater or less extent. Hence, by the use of an oscillograph, the best conditions as regards commutation may be obtained by adjusting the shunt across the reversing-pole coil until the flat portion of the oscillogram, corresponding to the short-circuit period, is brought up or down to the zero-line level. The author points out that, in the case of reversing-pole machines having very weak fields and very powerful armatures, sparkless running may be obtained in spite of the fact that the field on either side of the commutation zone is of the same polarity; oscillograms showing this latter effect are given, the curve of flux distribution exhibiting in this case 4 maxima per pole-pair (two positive and two negative), the depression between two maxima of the same sign being brought about by the commutating pole. The possibility of the existence of 4 maxima in the flux curve is a distinct disadvantage of inter-pole machines as compared with those having a distributed compensating winding arranged on the Ryan or Déri plan; for whilst in the latter there are only two maxima of relatively low value, in an inter-pole machine there may be 4 maxima, and two of these will be of higher value than in a Ryan or Déri machine (since the e.m.f.'s in a group of conductors between a brush-pair partly neutralise each other, requiring a larger total flux in the portion of the flux wave exhibiting the numerically higher maximum). The iron loss will therefore be greater, both on account of the larger maximum induction and on account of the doubled frequency of the magnetic cycles. A. H.

176. *Commutating Poles.* **F. Pelikan.** (Elektrotechn. Zeitschr. 28. pp. 26–29, Jan. 10, 1907.)—The results of various tests carried out by the author on a 3·75-kw. dynamo which had been fitted with inter-poles are described, and exhibited graphically in a series of diagrams. The flux distributions due to the main poles alone, to the commutating poles alone, to the combined effect of commutating poles and current in the short-circuited coils, to the combined effect of main and commutating poles, to the armature current alone, and to the joint action of main poles, commutating poles, armature current, and current in short-circuited coils, are shown by means of curves. Another set of curves relates to the changes taking place in the shape of the resultant commutating field and in the voltage across different portions of the brush contact surface as the armature current is increased. The resultant commutating field changes very irregularly, and from this the author draws the practical conclusion that it is a useless refinement to give the commutating pole-shoes any special shape. If the reversing poles alone are excited, their flux passes entirely through them, none of it going through the main poles. But when the machine is loaded, the reversing flux finds a return path through the neighbouring main pole of opposite polarity. The flux in each main pole remains constant from no load to full load, but the flux through

the armature and yoke varies. A method of calculating the ampere-turns required for the reversing poles is explained in detail. A. H.

177. *The Diameter of the Armature.* **L. A. Freudenberger.** (Electrical World, 49. pp. 144–145, Jan. 19, 1907.)—In the design of a direct-current machine, the determination of the diam. of the armature is of fundamental importance since all the other variables are more or less influenced by the value chosen for this diam. A formula for the diam. is found as follows: Let E be the e.m.f. per conductor generated, then—

$$E = p\pi l d B n / 10^8 \text{ volts,}$$

where p = fraction of armature covered by poles, l = length of armature (inches), d = diam. of armature (inches), B = magnetic intensity in the air-gap in lines per sq. in. just outside of the armature surface, n = revs. per sec. The power generated in the armature will be NEC, where N is the total number of armature conductors and C is the current in each conductor. In design we know the output W (watts) of the machine, and thus the efficiency η is given by $\eta = W/(W + RC^2)$ approx., where R is the resistance of the armature conductors in series. We have also $W/\eta = p\pi l d B n NC/10^8$. If n_1 be the number of ampere-conductors per inch of armature surface, we have $n_1 \pi d = NC$, and thus $W = \eta p \pi^2 l d^2 n_1 n / 10^8 = k l d^2 n$. In commercial machines the ampere-conductors n_1 per inch of armature varies from 200 to 600, and will depend on the output and type of machine, the constant being largest for well-designed machines. The value of n_1 depends on the space-factor. It is therefore higher for surface-wound armatures than for slot-wound armatures of the same capacity. For the largest sizes of surface-wound armatures (100 to 200 kw.) n_1 will exceed 600. In large bar-wound armatures the space-factor is high, but for very small machines (1 kw.) n_1 may be less than 200. The value of p usually varies from 0·6 and 0·8. If the poles are entirely of steel B may be 40 to 50 thousand lines per sq. in. For direct-coupled machines n is known. In other cases the speed is fixed by the max. permissible peripheral speed (3,000 to 5,000 ft. per min.). For a direct-coupled set the peripheral speed rarely exceeds 2,500 ft. per min. We have to assume a value for l/d. In multipolar machines we assume the value that makes the pole-faces approximately square. Similar considerations apply to alternators. A. R.

178. *Testing of Induction Motors.* **R. E. Hellmund.** (Elect. Rev., N.Y. 50. pp. 108–110, Jan. 19, 1907.)—Although the circle diagram furnishes a very convenient method of investigating the characteristics of an induction motor, the author points out that results obtained by means of this diagram are not always in as good agreement with experimentally determined values as might be desired. The discrepancy is particularly noticeable in the case of some of the newer motors, in which very high values of the induction are used, and is due to changes in the leakage factor. The author examines in detail the effect on the various components of the leakage (end, slot, and zigzag leakage) produced by changes in the core reluctance. In order to obtain a circle diagram which will be sufficiently accurate from no load up to full load, the no-load test should be carried out with a voltage less than the normal by an amount representing the primary resistance drop at full load; while the short-circuit test should be taken with full-load current flowing through the stator. A. H.

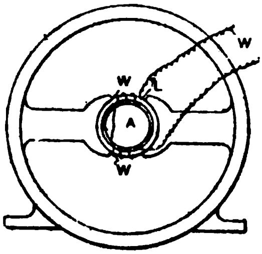
179. *Self-exciting Alternator.* (Electrical World, 48. pp. 1288–1289, Dec. 29, 1906.)—In the self-exciting alternator designed by W. Stanley [Abstract No. 1425 (1906)] the voltage generated at one pair of brushes on the commutator is used to supply the exciting current for the field, which is utilised for generating the e.m.f. between another set of brushes. In order to overcome the ohmic drop in the field coils due to the two separate magnetising currents, it is necessary to apply to the exciting circuits of the machine e.m.f.'s in phase with these currents. Methods of using a separate revolving-field transformer and of shifting the brushes were previously employed. In U.S. Pat. 838,144 issued to W. Stanley, a method is described which dispenses with the special rotating-field transformer, and yet makes it unnecessary to have any displacement of the brushes. Two auxiliary transformers are so wound that the e.m.f.'s produced at the secondary terminals are practically in quadrature with the e.m.f.'s produced in the respective rotor and stator windings. The arrangement is stated to be particularly advantageous when the stator and rotor windings are supplying equal amounts of power to the mains, as in this case the magnetising forces set up by the load currents in the halves of the secondaries practically neutralise one another. A. R.

180. *Alternator Armature Windings.* **H. M. Hobart** and **A. G. Ellis.** (Electrician, 58. pp. 441–443, Jan. 4; 480–483, Jan. 11, and pp. 517–519, Jan. 18, 1907.)—The authors examine the various types of alternating-current armature windings, and propose a system of classification by means of which any given winding may be described uniquely and succinctly. All windings may be divided into "whole-coiled" and "half-coiled." A "whole-coiled" winding is one in which there is one coil per phase per pole, while a "half-coiled" one (termed "hemitropic" by S. P. Thompson) has only one coil per phase per pair of poles. A coil may be embedded in two slots only, forming a "single" coil, or each side of it may be distributed over two, three, four, &c., slots; hence the terms "double," "triple," "quadruple," &c., coil. A multiple coil may be either a "spiral" coil or a "lap" coil; in the former the pitch of the conductors varies, in the latter it remains constant. The essential features of a winding are completely described by stating (1) whether it is whole-coiled or half-coiled; and (2) the multiplicity of the coil. It may, in addition, be advisable (though not necessary) to state the number of slots per pole per phase. In discussing the different types of windings, the authors briefly refer to their relative advantages and disadvantages. The methods of arranging the coil ends, and connecting the phases of a polyphase system, are also dealt with. A. H.

181. 970-*KV.A. Turbo-Alternator.* **A. Kolben.** (Elektrotechnik u. Maschinenbau, 25. pp. 1–8, Jan. 6, 1907. Elect. Engin. 39. pp. 118–120, Jan. 25, 1907.)—The author gives an illustrated description, containing full technical data and results of tests, of a 3-phase turbo-alternator designed for an output of 970 kilovolt-amps. at 450 volts, 50 ∿, at a speed of 1,500 r.p.m. The 4-pole magnet wheel consists of a single mass of Siemens-Martin steel, machined all over its surface. The poles are of rectangular cross-section, and are fitted with dove-tailed pole-shoes. The field coils are formed of edge-strip copper, 1·4 × 35 mm., the insulation between turns consisting of 0·3 mm. press-spahn. The field coils are compressed by hydraulic pressure before the pole-shoes, which hold them in position, are slipped over the poles. Bulging of the coils sideways is prevented by bronze castings having a perforated external cylindrical surface, which makes the entire surface of the rotor

practically continuous, and thereby prevents roaring of the machine when running. At the ends of the rotor, the field coils are supported by perforated bronze shields of special design, which act as fans and maintain a steady draught of air through the ventilating ducts in the rotor and stator. The diam. of the rotor is 72 cm., the axial length of the core 74·6 cm., and the ratio (pole-arc)/(pole-pitch) = 0·65. The cross-section of each pole is 1,440 sq. cm. The diam. of the thickest portion of the shaft is 24 cm., the journals being 12 cm. in diam. and 42 cm. long. Forced lubrication is used. The 4 field coils are connected in series, and each coil consists of 70 turns; the exciter voltage is 50. The stator has an external diam. of 128 cm., and a bore of 75 cm.; its axial length is 74 cm., and there are 9 ventilating ducts, each 1 cm. wide. There are 60 slots, corresponding to 5 slots per pole per phase. The slots are circular, 2·8 cm. in diam., and form nearly closed tunnels, communicating with the exterior through slits only 0·8 cm. wide. Each slot contains a single conductor having a bare diam. of 2·1 cm., and insulated to a diam. of 2·8 cm. by means of a micanite tube. The end connections consist of copper strip 6 × 50 mm. The mesh connection is used for the armature winding. The weights of the component parts are: Rotor steel, 1,450 kg.; rotor copper, 240 kg.; stator stampings, 8,600 kg.; stator copper, 325 kg. The efficiency at $\cos\phi = 1$ is 95·8 per cent., the losses being made up as follows: Bearing and air friction, 10 kw.; iron losses, 28·6 kw.; stator copper loss, 6 kw.; field copper and exciter loss, 5·6 kw. The rise of voltage on switching off full load is (as calculated by the Blondel-Arnold method) 4 per cent. at $\cos\phi = 1$, and 15 per cent at $\cos\phi = 0·8$. The final temperature rises when running at full load with $\cos\phi = 0·8$ are: Stator core, 58° C.; stator winding, 50° C.; rotor winding, 48° C. A. H.

182. *Regulating Device for Generators.* (Mech. Eng. 19. p. 68, Jan. 12, 1907.)—The device described is the invention of C. A. Parsons and A. H. Law, and is illustrated in the Fig. Between the poles of the generator is introduced a laminated ring L, which provides a leakage path for the main flux. This ring carries a winding WW, through which an alternating current proportional to the load current of the generator is sent. The effect produced is an increase in the reluctance of the leakage path, and a consequent increase in the flux entering the armature, whereby the armature e.m.f. is raised. A. H.



183. *Behaviour of Transformer on Capacity Load.* G. **Benischke.** (Elektrotechn. Zeitschr. 28. pp. 25–26, Jan. 10, 1907. Écl. Électr. 50. pp. 212–214, Feb. 9, 1907.)—By means of the general equations of a transformer, the author investigates the behaviour of a transformer whose secondary is connected across a condenser. Assuming the capacity and primary p.d. to remain constant, and the frequency to increase steadily, the changes in the primary and secondary currents are investigated. The primary current at first decreases with increase of frequency, passes through a minimum, and then rises to a resonance maximum. The secondary current, starting from a zero value, increases until it reaches a resonance maximum coinciding with the resonance maximum of the primary current. A. H.

184. *850-h.p. Winter-Eichberg Railway Motor.* **W. Reichel.** (Elektrische Kraftbetr. u. Bahnen, 5. pp. 68–78, Feb. 4, 1907.)—Two main difficulties present themselves in connection with the design of railway motors of very large size. One of these is the necessarily limited diameter of the motor armature, which depends on the height of the car floor; and the other is the difficulty of preventing an excessive temperature-rise. These difficulties have been surmounted in the 350-h.p. Winter-Eichberg motor recently built by the A.E.G. for the experimental track at Oranienburg [Abstract No. 94 (1907)] established by the State railway authorities. The motor has an outer stator diam. of about 1,200 mm., and a length of about 1,120 mm. (length of pinion not included). It is capable of working at 350 h.p. for one hour when running at 400 r.p.m. The most remarkable result achieved in connection with this motor is the very large continuous output—which is 250 h.p. at 500 r.p.m.—in comparison with the output based on the one hour's rating, the ratio of the two outputs being $\frac{350}{250}=1{\cdot}4$, whereas with the usual types of railway motors this ratio is 2·5 to 3. The commutation is stated to be quite satisfactory. The motor is a 6-pole one, works at a frequency of 25, and has a brush voltage of 280 at full load. Its full-load efficiency is in the neighbourhood of 90 per cent., and its power-factor is from 90 to 94·5 per cent. The large continuous output is secured by the use of forced ventilation, which is provided by an electrically-driven blower. A. H.

REFERENCES.

185. *Testing of Large Alternators.* (West. Electn. 39. p. 318, Oct. 20, 1906. Elect. Rev., N.Y. 49. pp. 816–817, Nov. 17, 1906. Electrician, 58. pp. 421–422, Dec. 28, 1906.)—A description is given of Behrend's method [Abstract No. 114 (1904)], and the results of some tests of a 1,000-kw. alternator. The core loss curve corresponding to various excitations as obtained by running the machine on open circuit was found to be in agreement with that given by Behrend's split-field method. The method is, however, applicable only to machines having a relatively large number of poles. A. H.

186. *Resistance Leads for Single-phase Commutator Motors.* (Elect. Engin. 39. p. 1, Jan. 4, 1907.)—B. G. Lamme has patented an arrangement in which the high-resistance connectors between the armature winding and the commutator, instead of being placed, as usual, at the bottom of the slots, are embedded in a series of tunnels below the slots. This, it is claimed, allows the core slots to be properly proportioned, and also prevents the conduction of heat from the resistance leads to the armature conductors. (U.S. Pat. 838,034). A. H.

187. *Theory of Single-phase Induction Motor.* **A. Still.** (Electrical World, 48. pp. 1108–1111, Dec. 8; 1152–1157, Dec. 15, and pp. 1202–1205, Dec. 22, 1906. Écl. Électr. 50. pp. 139–141, Jan. 26, 1907, *et seq.*)—The essential feature of the mode of treatment adopted by the author consists in replacing the rotor winding by two *fixed* short-circuited coils, the plane of one of which is (in a two-pole motor) parallel, and that of the other normal, to the axis of the stator field. The e.m.f. in the first coil is due to rotation, that in the second to transformer action. Torque-speed and other curves and circle diagrams are deduced on this assumption. A. H

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

188. *Long-span Transmission Lines.* **T. L. Kolkin.** (Elect. Rev. 59. pp. 1048–1049, Dec. 28, 1906.)—In a former paper [see Abstract No. 1857 (1906)] it was pointed out that iron poles were as cheap as wooden ones, if not cheaper, if spans of 50–60 m. were used. In the present paper the length of span which gives the minimum cost of iron poles per mile of line is investigated. The paper is illustrated with curves giving the relation between cost of poles and length of span, and in all cases there is a marked minimum of cost at between 80 and 120 m. span, the length of this span increasing with the size of the wire used. E. C. R.

189. *Electric Power Transmission.* **W. B. Esson.** (Engineer, 102. pp. 594–596, Dec. 14, 1906.)—Recent progress has tended towards increased pressures, up to 60,000 volts, with a view to cheapening the line. Three-phase armatures can be wound for pressures up to 20,000 volts, but as a rule 15,000 is not exceeded; beyond this, step-up transformers should be used. In designing high-pressure transmission lines the local and climatic conditions must be studied; the insulators are the weak points, and these can be diminished in number by increasing the length of the spans and using steel poles, 12 to the mile. On level ground the poles need be stiff only in a direction at right angles to the line to resist wind-pressure. The Semenza insulator, which is provided with an umbrella over the top dome, is reported to have given good results in rain, enabling the diameter of the insulator to be reduced from 10 in. to 6 in. with equal efficiency [see Abstract No. 1297 (1906)]. Lightning and surges are the most troublesome agencies met with on high-pressure overhead lines, and no satisfactory safeguard has yet been devised. For transformers above 30,000 volts oil insulation is imperative, and above 500 kw. water circulation must be provided to cool the oil. Oil-break switches are always used, and fuses have been entirely replaced by automatic circuit-breakers, which are used as sparingly as possible. Where each generator is grouped with its own transformers, many of the switches can be dispensed with. Economy of labour is enjoined, and ample space must be provided for switchgear.
A. H. A.

190. *Use of Two-phase Induction Motors on Single-phase Supply.* (Electrical Times, 30. pp. 854–856, Dec. 13, 1906.)—An account is given of the arrangements adopted at West Ham pending the introduction of a two-phase system of power supply. In view of the introduction of this system, it was undesirable to purchase a larger number of single-phase motors than were absolutely necessary. The plan was therefore adopted of installing two-phase motors throughout any factory requiring power. One of these motors, termed the pilot motor, is provided with a single-phase starting switch, while all the others are provided with two-phase starters. One phase of each starter is across the single-phase supply mains, while the other is connected across a set of bus-bars which are supplied from the second phase of the pilot

motor. When the latter has been started as a single-phase motor, all the others may be started as two-phase ones, a much larger starting torque being thereby obtained. The only change which will be necessary in changing over to the two-phase supply is the replacement of the single-phase starter of the pilot motor by a two-phase one. A. H.

191. *Improvements in the use of Hydraulic Accumulator Installations.* **F. Golwig.** (Elektrotechnik. u. Maschinenbau, 24. pp. 967–978, Dec. 2, 1906. Ind. Élect. 16. pp. 85–88, Jan. 25, 1907.)—The author gives a detailed description of the different methods employed in hydraulic installations in order to overcome the fluctuating power demand, which in many cases is several times larger than the normal requirements. A detailed account is also given of the method devised by the author for storing water without interfering with the water rights of users the other side of the fall. The author claims that by adopting his method, large and small water powers will be more effectively utilised. The article is fully illustrated, comprising a series of diagrams explanatory of the methods employed. [See also Abstract No. 755 (1906).] L. G.

192. *Disadvantages of Monocyclic System.* **F. Niethammer.** (Schweiz. Elektrot. Zeit. 4. pp. 1–2, Jan. 5, 1907.)—So long as the load on a monocyclic generator consists mainly of three-phase induction motors, the system closely resembles a three-phase one, *i.e.*, the three voltages differ by about 120° in phase and are nearly equal. As soon, however, as the main phase of the generator is called upon to supply a heavy lighting load, the system becomes strongly unbalanced, with the result that the motors draw abnormally heavy currents from two of the mains, and hardly any from the third. The motors run no better than on a single-phase supply, and may run even worse, as their third phase may send a generator current into the network. Results of actual tests confirming the above are given by the author; the tests were carried out at Brünn, where a monocyclic network is in use. A. H.

193. *Buffer Battery Alternating-current Plant in Germany.* (Ind. Élect. 16. pp. 14–16, Jan. 10, 1907.)—The arrangements described refer to a small generating station in Germany, the mean load of which was found to be only 80 kw., while the max. load rose to 100 kw. A buffer battery of 120 cells having a capacity of 648 amp.-hours at a 3-hour rate of discharge was installed, and the following method, worked out by the Siemens-Schuckert works, was adopted for utilising the buffer action of the battery. A synchronous motor, a continuous-current generator, and a rotary converter are arranged in line with each other and are mechanically coupled. The generator armature is directly across the battery, as is also its shunt field coil. The series field coil of the generator is across the brushes of the converter, whose slip-rings are connected to the secondaries of a series transformer having its primaries in the feeder circuit. The field frame of the rotary converter is so adjusted relatively to its armature that the ampere-turns of the latter are brought into direct opposition to the field ampere-turns; this is rendered possible by the fact that the converter is mechanically coupled to the synchronous motor. The exciting current of the rotary converter is adjusted so that at normal load no current is taken by its armature, and the excitation is maintained constant at this value. If the load increases, a current flows into the converter which passes into the

series field coil of the generator, weakening the field and causing the battery to drive it as a motor. The opposite effect takes place when the load decreases. A. H.

194. *Use of Buffer Batteries in connection with Alternators.* (Engineer, 103. p. 52, Jan. 11, 1907.)—The following arrangement has been patented by the Siemens-Schuckert works [Brit. Pat. No. 8677A of 1906]. The armature of the rotary converter is in series with that of a booster, the converter field being across the battery. The booster is provided with two field windings. One of these carries the main continuous current which is supplied to the continuous-current load connected across battery and converter (one end of the coil being connected to the junction of the converter and booster armatures, and the other to one of the continuous-current supply mains), while the other coil is supplied by an auxiliary converter which on its alternating-current side is connected across the secondary of a series transformer whose primary is traversed by the main alternating current supplied to the alternating network [see also Abstract No. 66 (1907)]. A. H.

195. *Comparison of Two- and Three-phase Systems for Generation, Transmission, and Distribution.* **M. A. Sammett.** (Canad. Elect. News, 16. pp. 843–847, Dec., 1906. West. Electn. 39. pp. 445–446, Dec. 1, 1906. Elect. Rev., N.Y. 49. pp. 927–929, Dec. 8, 1906. Abstract of paper read before the Canadian Soc. Civ. Engineers.)—For a given output, speed and voltage, and given size of machine, a three-phase generator is superior to a two-phase one as regards efficiency and temperature-rise. The switchboard equipment is, on the whole, slightly cheaper for a three-phase than a two-phase system. As regards transformers, the three-phase system is again the better. Since transmission would in any case be carried out on the three-phase system, as this requires less copper for a given drop in the line, it follows that if two-phase generation be adopted transformation from two- to three-phase must be effected by the Scott system of connections. There is in this case, with T-connected transformers, some danger of resonance, as if one of the phases should happen to be open, the high reactance of the high-voltage transformer will be in series with the capacity of the transmission line. Considering the question of frequency, from the regulation and capacity-current points of view a frequency of 25 is preferable to one of 60 for transmission purposes. On the other hand, from the generation and distribution standpoints, a frequency of 60 is preferable, as it affords greater flexibility in the choice of the most suitable speed, and is better for a lighting and induction motor load, a high-frequency induction motor being superior, as regards power-factor, to a low-frequency one. For a railway load operated by rotary converters, the lower frequency is known to be preferable. The author sums up his conclusions by saying that for a mixed lighting and power load, with a railway load not exceeding 33 per cent. of the total output, a three-phase 60-cycle system should be employed throughout, and all transformation should be accomplished by Δ-to-Δ connections. A. H.

196. *Power Measurement in Four-wire Three-phase Systems.* **E. Orlich.** (Elektrotechn. Zeitschr. 28. pp. 71–72, Jan. 24, 1907. Écl. Électr. 50. pp. 254–256, Feb. 16, 1907.)—The formulæ deduced by Aron [Abstract No. 1119 (1901)] and Stern [Abstract No. 107 (1904)] for the power in a three-phase system with a neutral wire are based on the assumption that the sum of the instantaneous star voltages is zero. The

author shows that this assumption is not a legitimate one, and that consequently meters whose connections are based on the above formulæ are subject to error. The error is particularly serious if the star voltage waves contain harmonics whose order is a multiple of 3; but it is present in any case when the load is an unbalanced one. Two experimental methods are described of determining the r.m.s. value of the algebraical sum of the star voltages. A. H

ELECTRICITY WORKS AND TRACTION SYSTEMS.

197. *Grand Rapids-Muskegon 66,000-volt Transmission System.* (Electrical World, 48. pp. 841–842, Nov. 3, 1906.)—The high-voltage system owned by the Grand Rapids-Muskegon Power Co., of Grand Rapids, Mich., has been in successful operation at 66,000 volts since April 1, 1906. The distances of transmission vary from 21 to 40 miles, and the total length of the 66,000-volt lines is about 75 miles. For some time recently the voltage has actually been 69,000. The line is constructed of wooden poles of Michigan and Idaho cedar and Southern cypress, the height varying from 45 to 60 ft. There are 40 poles per mile. Each pole is at the top fitted with two cross-arms, the upper one being short and lower one long. The lower arm carries two wires arranged symmetrically on opposite sides of the pole, while the third wire is supported at one end of the upper arm. The other end of this arm carries a No. 6 iron wire which is earthed every fifth pole for lightning protection; the earthing is effected by burying a coil of copper wire in the ground. The line conductors are 6 ft. apart, and consist of No. 2 solid copper wire. They are supported by Locke insulators 14 in. in diam. and 18 in. high. Wooden insulator pins are used on straight line work and iron pins on curves. The experience so far gained with this line has been entirely satisfactory: the only interruption which occurred was due to the shattering of two insulators by lightning. It is intended to proceed shortly with the erection of a duplicate transmission line from Croton Dam to Grand Rapids. This line may possibly be operated at 100,000 volts. It will be of the steel tower type of construction, the triangular towers being placed 500 ft. apart. A. H.

198. *Accumulator Locomotive Traction in Argentina.* E. Volpatti. (La Ingenieria, Buenos Aires, 198. p. 225, Aug. 15, 1906. Elekt. Bahnen, 4. pp. 667–668, Dec. 4, 1906. Abstract.)—A description of the accumulator locomotive employed on a military strategic railway for coast artillery purposes. The railway is 75 km. long. The power plant for charging the batteries has two 50-h.p. suction gas producers and engines driving 2,200-volt, 35-kilovolt-amp., 50-∿ generators. The charging current is taken from the 300-volt, direct-current side of a converter. The locomotive can draw 30 tons at 25 km. per hour, and has two motors, each of 36 and 56 h.p. normal and max. output respectively. The battery consists of 160 cells of 324 amp.-hours at the 3-hour rate. The considerations leading to the adoption of accumulator traction were: readiness for immediate use, no fuel consumption when not in use, no smoke or steam to be seen from the sea, no sparking at rails, safety from fire to surrounding fields. L. H. W.

199. *Electrical Haulage on the Canal d'Aire et de la Deule at Douai.* (Electrician, 58. pp. 362–364, Dec. 21, 1906.)—One of the earliest and most extensive applications of electrical energy for the purpose of hauling barges along a canal has been made near Douai, on one of the French canals main-

tained by Government. The barges are of the standard size adopted on French canals, and carry a load of 290 tons. A tractive effort of 8 lbs. per ton at a speed of 1·9 miles per hour is required owing to the narrowness of the canals. The actual length now equipped with electrical haulage is 58 km. The locomotive is simply and cheaply constructed. The framework is built up of channel and other rolled sections, and the motors and gearing are cased in ⅜-in. plating. Each of the axles is driven independently by a 20-h.p. motor. When towing barges the current taken is about 20 amps. at 500 volts. The trolley line is supported on trolley ears which are carried on wooden posts about 6-in. diam. at the base, the average height of the trolley being 17 ft. The track is 40-lb. flange-bottomed rails laid on wooden sleepers. The supply of power is produced in four generating stations. The results obtained with electrical haulage on rails has been so satisfactory that several other French companies are about to install it. W. J. C.

200. *Electrification of the West Jersey and Seashore Railroad.* (Elect. Rev., N.Y. 49. pp. 717–722, Nov. 3, and pp. 761–765, Nov. 10, 1906. Street Rly. Journ. 28. pp. 928–946, Nov. 10, 1906. Electrician, 58. pp. 402–407, Dec. 28, 1906. Abstract.)—The Pennsylvania Railroad has equipped for electric operation its West Jersey and Seashore Branch, involving the electrification of a main line double-track steam road from terminal to terminal of a greater length than any electrified steam road in America. The line extends from Camden, New Jersey, *viâ* Newfield, to Atlantic City (65 miles), and from Newfield to Millville (10 miles). The general scheme of electrification consists of generating alternating-current power at 6,600 volts at the power-house, stepped up to 33,000 volts for transmission to the sub-stations, where it is reduced to 430 volts, and then led to the rotaries and converted to direct current at 650 volts for feeding the third rail. The main portion of the electric equipment of the power-house is given in the following list: Three 2,000-kw., 6,600-volt, 25-cycle, 3-phase Curtis turbo-generators; two 75-kw. 125-volt Curtis turbo-exciters. The 33,000-volt transmission line is in duplicate throughout. It is Y-connected with the neutral grounded. For initial service, 62 passenger cars and 6 combination baggage and mail cars have been provided. All the cars are motor cars, there being no trailers. The speed attained is 60 miles per hour on the level straight.

W. J. C.

201. *Great Northern, Piccadilly, and Brompton Railway.* (Electrician, 58. pp. 281–284, Dec. 7, and pp. 322–324, Dec. 14, 1906. Tram. Rly. World, 20. pp. 519–534, Dec. 6, 1906.)—The total capital expended on this railway is given at £7,206,000, or about £800,000 per mile for each of the 9 miles. The uniform fare system will not be adopted owing to the length of the route. The track construction is the same as was first adopted on the Baker Street and Waterloo Railway. The general principle consists of supporting the central portion of each sleeper rigidly on a concrete foundation, while the extremities under the rails rest on a loose packing of crushed granite. The sleepers are of uninflammable Australian Karri wood. Power for working the line is supplied from the power-house of the Underground Electric Railways Co. of London. Three new substations have been established at Holloway, Russell Square, and Hyde Park Corner. The tunnel lamps are fed from a 3-phase supply at 220 volts obtained from transformers in the sub-stations, in order to be entirely independent of the continuous-current

traction supply. Nineteen exhaust fans, each capable of drawing out 18,500 cub. ft. of air per min., are provided for ventilating purposes. The Westinghouse electro-pneumatic system of automatic signalling is used exclusively. The rolling stock consists of 72 motor cars and 144 trailers. The control is on the standard Sprague-Thomson-Houston multiple unit system. The depth of the tunnels below the surface varies considerably; the minimum is 23 ft., and the maximum 123 ft. All the underground stations, with the exception of Gillespie Road, are provided with lifts. When completed there will be in all 60 electric lifts. W. J. C.

202. *Wangen-on-the-Aare Electricity Works.* **K. Meyer.** (Zeitschr. Vereines Deutsch. Ing. 50. pp. 713–721, May 12; 862–870, June 2; 930–937, June 16; and pp. 986–998, June 23, 1906.)—The author gives a detailed illustrated description of the hydro-electric plant at Wangen. There are at present four 1,250-kilovolt-amp., 11,000-volt, 50-∿, 150 r.p.m., 3-phase, Lahmeyer alternators, each coupled direct to a pair of 1,500-h.p. double Francis turbines. The external diam. of the magnet wheel is 3,677 mm., and the bore of the armature 3,700 mm. There are 2 semi-closed slots per pole per phase, each 25 mm. wide and 45 mm. deep. The length of the armature core in an axial direction is 350 mm. Transmission takes place at about 10,000 volts in the neighbourhood of the generating station, while for outlying regions the voltage is stepped up to 25,000 by means of oil-insulated, water-cooled transformers. A. H

203. *Rehabilitation of the Philadelphia and West Chester Traction Co.'s Properties.* (Street Rly. Journ. 28. pp. 316–330, Sept. 1, 1906.)—The Philadelphia and West Chester Traction Co. is operating 33 miles of track in a residential district extending 20 miles westward from Philadelphia. For 1905 the receipts were 11d. per car-mile, £1,600 per mile of track, 18s. per car-hour. The receipts per mile of track are high, but the receipts per car-mile and per car-hour are low because of the liberal service given. The company stands prepared to adhere to this policy, in the belief that it will the more quickly build up the residential district served by the line. *The Track.*—70-lb. A.S.C.E. T-section rails are employed on chestnut ties. The roadbed is rock ballasted throughout, with from 6 in. to 8 in. of stone under the ties. The track is bonded with 9-in. No. 0000 Mayer and Englund bonds. A number of bridges and viaducts have been made with a view to eliminating grades and curves. These are capable of supporting cars weighing 50 tons, coupled together in trains of two or three cars, and travelling at 50 m.p.h. *Effect of Grades on Cost of Operation.*—The article goes into considerable detail regarding Herrick's method of estimating the extent to which it is justifiable to lay out capital in decreasing grades. The principle of the method consists of ascertaining the extent to which it is practicable to reduce grades, by forming an equation, one side of which is the cost involved in the reduction of the grade and the annual charge for this cost, and the other side of which represents the saving effected in power, time, and maintenance. It was found that by cutting down from a 5 per cent. grade to a 3 per cent. grade for a distance of 4,700 ft. outbound, the allowable investment would be £2,080. That is to say, the economy in car operation secured by cutting down the grade would be equivalent to 10 per cent. on that amount. *Cost of Stops.*—This is treated in a similar manner. The particulars of the rolling stock employed on this road are set forth in Table I.:—

TABLE I.

Type of Car.	Seating Capacity.	Trucks.	Motors.	Motor H.P.	Weight of Car Complete Empty.	H.P. per Ton.	Kw.-hrs. per Car-mile.	Cost per Car-mile in pence.
A closed ...	40	Brill 27-G	4 West 68	160	14 tons	11·4	2·7	2·02
B closed ...	40	Brill 27-E	4 West 68	160	15 „	10·4	2·9	2·17
C closed ...	40	Brill 27-E	4 West 68	160	15 „	10·4	3·8	2·85
D 17 closed	48	Baldwin M. C. B.	4 G. E. 73	300	30 „	9·8	4·5	3·37
D 18 closed	48	Baldwin M. C. B.	4 G. E. 73	300	30 „	9·8	4·2	3·15
E open......	84	Brill 27-G	4 West 68	160	12 „	13·1	2·6	1·95

It will be seen that six types of cars are employed ; for these six types the cost of stops has been estimated by Herrick to be as shown in Table II. :—

TABLE II.

COST OF STOPS IN FRACTION OF A PENNY ON VARIOUS GRADES.

Platform expense taken at 20d. per hour and cost of power at the motor at 0·8d. per kw.-hour.

Type of Car.	Grades in Per Cent.							
	0	1	2	3	4	5	6	7
A..............	0·10	0·10	0·11	0·12	0·14	0·15	0·17	0·21
B..............	0·9	0·10	0·10	0·12	0·12	0·13	0·15	0·19
C..............	0·10	0·11	0·12	0·12	0·13	0·15	0·18	0·12
D17	0·12	0·12	0·13	0·14	0·16	0·18	0·22	0·29
D18	0·12	0·13	0·14	0·15	0·18	0·19	0·22	0·28
E	0·06	0·07	0·07	0·08	0·08	0·09	0·11	0·13

Rolling Stock.—The management is of the opinion that strikingly elaborate rolling stock is justifiable in the interests of increased traffic in spite of its greater weight, and of the 1¼d. to 1½d. greater operating cost per car-mile. For the six different types of rolling stock employed, the cost per car-mile is shown in the last column of Table I. Comparative tests have been made of the friction coefficient of this rolling stock of various grades, as well as of the current consumption, and the results are shown in two tables, of which the latter is reproduced in part.

CURRENT CONSUMPTION OF DIFFERENT TYPES OF EQUIPMENT FOR VARIOUS GRADES.

Car.	0		1 Per Cent.		3 Per Cent.		5 Per Cent.	
	Amp.	M.P.H.	Amp.	M.P.H.	Amp.	M.P.H.	Amp.	M.P.H.
A	110	25	130	23·5	155	21·5	215	18·0
B	96	26·3	100	26·0	110	25·0	160	22·0
C	160	26·0	180	25·0	210	23·5	270	21·0
D17..............	180	29·5	190	27·5	220	25·0	360	19·5
D18..............	170	29·5	190	28·0	200	26·8	300	23·5
E	95	25·5	110	24·5	140	22·0	240	18

There are two power stations, the rated output capacity of which is 800 and 1,000 kw. respectively and the max. capacity 1,200 and 1,500 kw. respectively. One feature of the power-house installation is the concrete coal bunkers which have a capacity of 450 metric tons. H. M. H

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

204. *Development of Electric Traction.* **R. de Valbreuze.** (Soc. Int. Élect., Bull. 7. pp. 11–75, Jan., 1907.)—After a brief historical sketch, the author describes the various systems of traction now in use on electric railways. The direct-current system is exemplified by the New York Central Railroad, and the disadvantages of the low pressure and large currents are pointed out; the Valtelina Railway and the Simplon Tunnel, on the three-phase system, are next dealt with and critically discussed. Single-phase systems employing respectively series and repulsion motors, and modifications of these, are described with examples, and the advantages of the high pressure and single overhead line are explained, though the greater weight and lower efficiency of the equipment have to be set against these. Finally the direct-current system at high pressure is discussed, the highest pressure in use being 2,000 volts, though experiments are being made with 3,200 volts; the commutation difficulty can be overcome. The author concludes with a summary of the advantages of electric over steam traction, and of the special features of each system. A. H. A.

205. *Technical Details of existing Single-phase Railways.* **H. Somach.** (Elektrische Kraftbetr. u. Bahnen, 5. pp. 28–30, Jan. 14, 1907.)—The author points out that single-phase railway practice is still far from having been standardised, as is shown by a comparison of the various lines at present in existence. The frequencies in use are 16, 25, 40, and 42. The lowest frequency does not admit of the use of the current for lighting purposes, and for this reason the author expresses himself in favour of frequencies not below 20. As regards methods of control, both auto-transformers or compensators and induction regulators have been tried, but after some experience the latter seem to have been abandoned (they add considerably to the weight of the equipment and lower the efficiency). The regulating transformers are generally placed underneath the floor of the car. The motors may be left connected permanently in parallel or arranged in parallel-series groups. In America it is the usual practice to connect all the field windings in series with each other and all the armatures in series; this allows of the use of armature voltages not exceeding 200–300 volts, and at the same time does away with the use of very heavy conductors in the car wiring. The controllers are of simpler construction than those for continuous currents. In the best forms of construction, all the high-voltage apparatus is grouped together in a fire-proof chamber in the driver's cab. A special precaution has been adopted by the General Electric Co. on the Schenectady-Ballston line to prevent the car from being raised to a high potential in case the car wheels become insulated from the rails by sand or snow. This consists in providing a relay which trips the main switch as soon as the contact between wheels and rails becomes defective. For short lines the trolley voltages have ranged from

[1] Non-electrical Automobiles are described in the Section dealing with Steam and Gas Engines.

8,000 to 6,000, but in connection with main-line experiments 15,000 to 22,000 volts have been used. The catenary type of suspension seems to have given satisfactory results. A. H.

206. *New Overhead Conductor.* **J. Mayer.** (Street Rly. Journ. 28. pp. 1062–1068, Dec. 1, 1906. Extracts from paper read before the Amer. Soc. Civ. Engin., Nov. 21, 1906.)—The author advocates for the overhead conductor for heavy electric traction a soft steel rod of circular or figure-8 section, 1¼ in. in diam., with suspenders 12 ft. apart, for a speed of 80 m.p.h., the rigid part of the collector above the supporting springs being 25 lb. in weight. With this conductor a strong and durable collector can be used, and the suspension difficulties are overcome, as the suspenders are never in compression. The advantages over a wire are pointed out in detail. In the *discussion*, **F. J. Sprague** advocated higher pressures, and preferred third rail with direct current to overhead conductor with alternating current. He set out the reasons for his conclusions, stating that the weight and cost of the motor equipment and the cost of the generating station were greater for single-phase than for direct current, while the line construction would cost no less. A. H. A.

207. *Cost of Concrete Track Construction in St. Louis Streets.* **R. McCulloch.** (Eng. Record, 54. p. 588, Nov. 24, 1906. From Journal of the Assoc. of Engin. Societies.)—The reconstruction of the street railway track on Olive Street, St. Louis, involving the removal of an old concrete cable conduit and the laying of a concrete base for the new track has made possible the collection of some interesting data. The old concrete was broken by means of blasting charges intended to be strong enough to break the concrete and do no other damage. 1¼-in. blast holes 7 to 8 in. deep were drilled, 4 between each pair of yokes, and in each hole a 0·1 lb. charge of 40 per cent. dynamite was used. The old yokes and rails were then torn up and the loosened concrete excavated to a depth of 21 in. The new track was lined and surfaced by means of wooden blocks under the ties, and concrete was tamped in place under and around the ties. The concrete was a 1 : 2½ : 6½ mixture of Portland cement, river sand, and crushed limestone. The quantity required per linear ft. of track was 0·278 cub. yard. The total cost of concrete per mile of single track was $4,551.86. An account, giving the details of the work, was read before the Engineers' Club of St. Louis by the author. Diagrams are given of the cross-section of finished track and the location of blasting holes. C. E. A.

208. *Tramway Permanent-way Construction.* **A. Paterson, Jr.** (Inst. Civ. Engin., Proc. 165. pp. 238–248, 1905–1906.)—The author takes exception to the method of packing the rails after the concrete bed has been laid, on account of the liability to leave spaces under the rails which may become filled with water, leading to the destruction of the pavement. He prefers to support the rails on old setts in the excavation, and to put in the concrete to a level ½ in. above the bottom of the rail flange; after the concrete has dried slightly, the packing is beaten into it under the rails. The precautions necessary to ensure success are detailed. To pack rails which under traffic have worked loose, the concrete is removed to a depth of 1 in. under the rail flange, and granite chippings are packed under the rail; pitch-grout, poured in hot, is then used to fill the interstices. The author objects to the proposal to lay the rails on longitudinal timbers, owing to the probable detrimental

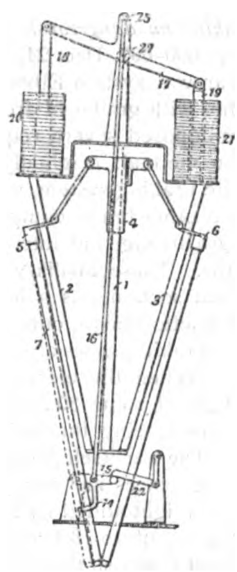
action on the adjoining pavement. After considering the welding of rail-joints, which he regards as unsatisfactory and expensive, the author recommends the continuous fishplate joint, which, on a busy track 20 miles long, in four years has not developed a single working joint. The anchor joint is objectionable because it is more rigid than the rest of the rail, and because it tends to act as a pump, destroying the paving. It is important to prevent the communication of vibration from the rail to the pavement; sand is the best material for the bedding, without cement, and the setts should be of uniform depth. For filling the space between the setts and the rail web, pitch-grout is recommended, with suitable precautions. Three-inch setts should be used for paving, hard next the rail, and softer elsewhere. In laying wood paving the floating must be true, and the joints tight except at the ends; 4 in. depth is sufficient. The tie-bars should be cranked, so as to lie below the blocks. A. H. A.

209. *Electromagnetic Braking on dangerously steep Grades.* **W. Mattersdorff.** (Elekt. Bahnen, 4. pp. 690–692, Dec. 24, 1906.)—The writer describes a system employed on the tramway system Elberfeld-Cronenfeld-Remscheid, where there are long stretches with grades of from 1 in 18 to 1 in 10·6. The local authorities have always imposed severe requirements as regards brake equipment; nevertheless, the methods originally prescribed proved insufficient, and the electromagnetic braking system, which the writer describes in this article, was added to the other brake equipments of the tramcars. On the dangerous grades there are arranged at intervals short lengths of double rail in between the main rails. These auxiliary rails are devoted exclusively to braking purposes, and each section has a length of 50 m. Each car is provided with two electromagnetic brakes, one supported over each auxiliary rail. When unexcited, these braking shoes are supported from 12 to 15 mm. above the level of the rail. When the electromagnets of the brakes are excited with a current strength of some 30 amps., each brake exerts a pull amounting to 1·9 tons, thus increasing the weight of the car available for adhesion by some 3·8 tons. The car itself weighs empty some 10 tons, and when all the seats and standing-places are occupied the weight is 12·3 tons. Thus the 3·8 tons equivalent weight added by the electromagnets raises the adhesive effect by some 31 per cent. to 16·1 tons. At each end of the 50-m. stretch of rail the rails are bent down so that the brake shoe shall be carried up on to the normal surface of the rail without shock; for when the brake shoe is excited a rubbing contact is established between the brake shoe and the rail. The braking rails are of flat iron, measuring 30 × 30 mm. in section. Their surface is 50 mm. above that of the upper surface of the running rails. Thus the braking rails do not interpose any obstacle to traffic crossing the line. These braking rails are only installed for a very small percentage of the total distance, and, as already stated, they are in short lengths of 50 m. each. The motorman has instructions to switch on the brakes at the beginning of the grade; they are then left on, and the braking is automatic. Thus, when the car is passing over stretches not furnished with braking rails, the car is checked only by the braking effect of the motor shortcircuited through the brake coils, but whenever a length of braking rail is reached the car is further and much more severely checked by the action of this track rail. If the car is sufficiently checked to be almost brought to rest, the braking action of the track rail is reduced to almost nothing, whereupon the car accelerates again, to be again checked

when the next stretch of braking rail is reached. Of course the motorman can further influence the speed of the car on the down grade by a judicious use of the hand brakes, which, in the case of this equipment, actuate two independent sets of brake shoes bearing respectively on the outer and inner sides of the wheels. It has been found that the costs of maintenance of this auxiliary rail brake system are very low indeed, and great satisfaction is felt with the results obtained. H. M. H.

ELECTRIC LAMPS AND LIGHTING.

210. *Lewis' Inclined Carbon Arc Lamp.* (Brit. Pat. 20,609 of 1905. Engineering, 82. p. 817, Dec. 14, 1906. Abstract.)—In this lamp, a rocking beam 17, 25, which is actuated by the solenoids 20, 21, is connected by a link 16 to a lever 15 provided with an eye 14 through which the carbon 7 passes, and which moves outwards to strike the arc when the link 16 is depressed by the



action of the series coil 20. The lever 15 supports and actuates the clutch-lever 22. The carbon holders 5, 6 are connected by links to a central slide 4, so that the clutching of the right-hand carbon clamps the whole system. By arranging the centres 25, 27 as shown, the lamp cannot be rendered inoperative by pushing up the link 16, as is the case in some existing inclined carbon lamps. C. K. F

211. *Magazine Arc Lamp.* (Brit. Pat. 26,854 of 1905. Engineering, 83. p. 33, Jan. 4, 1907. Abstract.)—This lamp, which is patented by B. M. Drake, A. D. Jones, and the Jandus Arc Lamp and Electric Co., consists of two cylindrical carbon magazines, which are rotatable about convergent axes, and each of which is provided with a star-like series of stops arranged at a short distance from its lower end, the carbons resting on these stops before and whilst they are being burnt. The magazines are geared together so as to rotate in opposite directions at equal speeds, and are each rotated in one direction by means of a clock spring acting, *e.g.*, on one magazine, and in the

other direction by means of a cam clutch, which acts, *e.g.*, on the other magazine, and is controlled by means of the regulating solenoid. When the solenoid is de-energised the spring rotates the magazines so as to bring the sides of a pair of carbons into contact in or near the plane joining the axes of the magazines; when the lamp receives current the cam clutch rotates the magazines so as to strike the arc. The arc thus appears to be between the inner sides of the carbons. C. K. F.

212. *The "Z" (Zirconium) Lamp.* (Journ. f. Gasbeleuchtung, 49. pp. 989–990, Nov. 10, 1906.)—Deals briefly with the new "Z" lamp of the Zirconium Lamp Co., for voltages from 1·5 to 220, and having an energy consumption of about 1 watt per Hefner candle. For 110 volts the smallest size is 35 Hefners, and for 220 volts 70 Hefners. The composition of the filament is not stated, but the life is claimed to be from 500 to 1,000 hours without diminution (appreciable) of c.p. The lamps are also said not to blacken. Actual tests, however, made on 110-volt, 56-c.p. (Hefner) lamps, gave very poor results, most of the lamps being destroyed in less than 150 hours, and some becoming quite blackened. With three 35-c.p. lamps from a single shipment, one showed a life of 850 hours and a second 450 hours with practically no loss of c.p. The third lamp lasted over 600 hours, but became much blackened. L. H. W.

213. *New Incandescent Lamps.* **C. H. Sharp.** (Amer. Inst. Elect. Engin., Proc. 25. pp. 809–841, Dec., 1906. Abstracts in Elect. Rev., N.Y. 49. pp. 938–942, Dec. 8, 1906. Electrician, 58. pp. 602–605, Feb. 1, and pp. 649–652, Feb. 8, 1907.)—This paper contains facts relating to the newer types of metallic filaments. Tungsten filaments are said to fuse at 3,200° C., and are made having a diam. of 0·044 mm. The filaments are very fragile, and though they weld together again at a fracture they are very liable to break again at the weld. In tantalum lamps the welds are generally very firm, but this is not the case with tungsten. The temperature-coefficients for tantalum, osmium, and tungsten are respectively 0·284, 0·372, and 0·488 per cent. per 1° C., as determined by comparison of the resistance at ordinary temperatures with that at 100° C. With 5 per cent. increase in voltage the increase in c.p. for carbon filaments is 30 per cent., for metallised filaments 27 per cent., for tantalum 22 per cent., and for tungsten 20 per cent., the watts per c.p. being decreased by 15, 13, 11, and 10 per cent. respectively. The effect of frequency on the life of the tantalum lamp is shown in the following table, and

Mortality Table—Tantalum Lamps.	130 Cycles.			60 Cycles.	25 Cycles.	Direct Current.
	1·87 Watts per Candle.	2·49 Watts per Candle.	3·1 Watts per Candle.	Rated Volts.	Rated Volts.	Rated Volts.
Number of lamps ...	10	10	10	15	16	20
First burnt out.........	84 hrs.	92 hrs.	110 hrs.	28 hrs.	177 hrs.	180 hrs.
50% burned out	114 "	167 "	238 "	118 "	271 "	641 "
100% burned out......	290 "	335 "	447 "	476 "	641 "	—
Total hours of test ...	290 "	335 "	447 "	397 "	641 "	775 "
Average life of group	122 "	203 "	248 "	151 "	324 "	606 "

the result of alternate current is generally to break the filament up into very short fragments, which weld together again. Tungsten lamps are not affected

in this way, and their lives on direct and alternate current are the same. Figures and curves are given relating to tests which have been made on tantalum lamps on direct current, and also on tungsten, osram, osmin, and Kuzel lamps. The light of the tungsten lamps is much whiter than that of tantalum, and they are probably worked at a higher temperature. Some stroboscopic tests were made with tungsten lamps in order to ascertain whether they are likely to be suitable for low frequencies; but at present such tests are very incomplete, though it seems likely that under such conditions the tungsten lamp will give even worse results than the ordinary carbon filament. W. H. S.

214. *"Helion" Filament Incandescent Lamp.* **H. C. Parker** and **W. G. Clark.** (Electrical World, 49. pp. 10–11, Jan. 5, 1907. Paper read before the Amer. Physical Soc., Dec. 29, 1906. Electrician, 58. pp. 567–569, Jan. 25, 1907. Abstract.)—"The filament is composed largely of silicon, which is reduced and deposited, together with the other materials, under very exact conditions, the base being a special carbon filament on which the deposit is made." No further information is given as to the construction of the filament. It gives a very white light, and though not metallic in the proper sense, it possesses the property of welding together at a fracture. At first the temperature-coefficient is negative, but after about 1,375° the resistance increases slightly up to 1,720°, above which it decreases again slightly. Some lamps have had a life of 1,270 hours. The c.p. shows a tendency to increase during the running, but after a certain period it decreases to about its original value. Various tests are quoted, but they have not been carried out on the usual commercial basis. W. H. S.

215. *New Tungsten Lamp.* (Brit. Pat. 27,002. of 1905. Engineer, 103. p. 78, Jan. 18, 1907. Abstract.)—A patent has been taken out by J. Lux for a lamp filament composed of tungsten or molybdenum. The acid hydroxide or trioxide of tungsten or molybdenum is triturated with an excess of ammonia solution or with a solution of a mono- or poly-amine, especially a nitrogen base of an alcohol radical, such as butylamine or methylethylamine; a compact tough mass is obtained which can be formed into filaments. The filaments are heated to incandescence with exclusion of air, and become of a dark colour, being then composed of metal or low oxides. This process renders them conductors, and they can then be further heated by the passage of an electric current, whereby the particles become welded together and the reduction to metal is completed. The resulting filaments consist of pure tungsten or molybdenum. W. H. S.

216. *British Standard Carbon Filament Glow-lamps.* (Elect. Engin. 39. pp. 94–95, Jan. 18, 1907. Elect. Engineering, 1. pp. 141–142, Jan. 24, 1907.)—The standard specification for carbon filament glow-lamps issued by the sub-committee on physical standards of the Engineering Standards Committee is reproduced in part, and it is expected that the same will come into general use in England from next July. The standard of light adopted is a 10-c.p. Vernon Harcourt pentane lamp kept at the National Physical Laboratory. Secondary standards for the tests described will be suitable carbon filament glow-lamps certified to be in accordance with the standard. The useful life of a carbon filament glow-lamp is defined as the time taken for the mean horizontal c.p. of the lamp to drop 20 per cent. from its standard value when

run under standard conditions. Lamps of 8, 12, 16, 25, and 32, mean horizontal c.p. are standarised for pressures of 110 and 220 volts. They are divided into two classes, having a useful life respectively of 400 and 800 hours. The tests to which the lamps should be subjected are as follows: (1) Size, workmanship, and uniformity of shape (mechanical defects); (2) insulation; (3) vacuum; (4) initial c.p.; (5) watts per mean horizontal c.p.; (6) total watts; (7) life tests. In an appendix to the specification the maximum dimensions for lamps are recommended. The tables of standard rating and limits are reproduced :—

Table and Reference Letter.	Standard Rating.				Individual Limits.		Average Limits.		Watts. Per M.H.C.P. Limits.
	M.H.C.P.	Watts per M.H.C.P.	Total Watts.	Candle Hrs. Area at Standard Efficiency.	C.P.	Total Watts.	C.P.	Total Watts.	
A.	8	3·25	26·0	2,900	7–9	23·4–28·6	7·4–8·6	24·2–27·8	2·7–3·8
	12	3·20	38·4	4,350	10·5–13·5	34·6–42·2	11·0–13·0	35·7–41·1	2·6–3·8
110 Volts.	16	3·10	49·6	5,800	14–18	45·6–53·7	14·7–17·3	47·1–52·1	2·6–3·6
Useful Life	25	3·15	78·75	9,100	22–28	72·4–85·0	23·0–27·0	74·8–82·8	2·6–3·6
400 hours.	32	3·15	100·8	11,600	28–36	92·8–108·8	29·5–34·5	95·8–105·8	2·6–3·6
B.	8	3·90	31·2	2,900	7–9	28·1–34·3	7·4–8·6	29·1–33·3	3·2–4·6
	12	3·80	45·6	4,350	10·5–13·5	41·1–50·1	11·1–12·9	42·4–48·8	3·1–4·5
220 Volts.	16	3·70	59·2	5,800	14–18	54·5–63·9	14·75–17·25	56·3–62·1	3·1–4·3
400 hours.	25	3·80	95·0	9,100	22–28	87·4–102·6	23·3–26·8	90·8–99·7	3·2–4·4
	32	3·80	121·6	11,600	28–36	111·9–131·3	29·5–34·5	115·6–127·6	3·2–4·4
C.	8	3·75	30·0	5,800	7–9	27–33	7·4–8·6	27·9–32·1	3·1–4·4
	12	3·60	43·2	8,700	10·5–13·5	38·9–47·5	11·1–12·9	40·2–46·2	3·0–4·2
110 Volts.	16	3·50	56·0	11,600	14–18	51·5–60·5	14·75–17·25	53·2–58·8	3·0–4·0
800 hours.	25	3·60	90·0	18,200	22–28	82·8–97·2	23·2–26·8	85·5–94·5	3·1–4·1
	32	3·60	115·2	23,200	28–36	106·0–124·4	29·5–34·5	109·5–120·9	3·1–4·1
D.	8	4·50	36·0	5,800	7–9	32·4–39·6	7·4–8·6	33·5–38·5	3·7–5·3
	12	4·20	50·4	8,700	10·5–13·5	45·4–55·4	11·1–12·9	46·9–53·9	3·5–4·9
220 Volts.	16	4·10	65·6	11,600	14–18	60·4–70·8	14·75–17·25	62·4–68·8	3·5–4·7
800 hours.	25	4·25	106·2	18,200	22–28	97·7–114·7	23·3–26·8	100·9–111·5	3·6–4·9
	32	4·25	136·0	23,200	28–36	125·2–146·8	29·5–34·5	129·2–142·8	3·6–4·9

L. G.

REFERENCES.

217. *Chart for calculating the Cost of Electric Energy Supplied from Central Stations.* **K. Kramář.** (Elektrotechnik u. Maschinenbau, 24. pp. 1035–1038, Dec. 23, 1906.)—This chart contains a number of graphs indicating how the various items making up the total cost of a kw.-hour vary, *e.g.*, with price of coal, consumption of coal per kw.-hour, the total number of units generated per year, the capital sunk in the installation, &c. A short *résumé* is also given of the usual method of calculating these costs. C. K. F.

218. *Curtis Turbo-alternators at Nice.* (Ind. Élect. 16. pp. 7–14, Jan. 10, 1907.)—An illustrated account of the turbo-alternators in the generating station at Nice, which is stated to be the first generating station in France that has adopted this type of plant. There are two units, each of 800-kw. capacity. The full-load steam consumption is said to amount to 7·77 kg. per kw.-hour. A. H.

219. *Regenerative Control for Series Motors.* (Schweiz. Elektrot. Zeit. 4. p. 35, Jan. 19, 1907.)—In Swiss Pat. No. 36,123, the Oerlikon Co. describe an arrangement whereby the ordinary series-wound, continuous-current motors used on tramcars may be made to return energy to the line. For this purpose the motors are converted into separately excited generators, their fields being supplied with current from a special exciter carried on the car. A. H.

TELEGRAPHY AND TELEPHONY.

220. *Multiple and Simultaneous Telegraphy.* (Brit. Pat. 25,754 of 1905. Engineer, 103. p. 78, Jan. 18, 1907. Abstract.)—In the method devised by F. Lori and L. Solari there are at the transmitter station several sources of e.m.f. of different frequency generated by as many alternators. Each of the latter acts by means of a contact-breaker—for instance, a Morse manipulator —on the primary circuit of a transformer. The secondary circuits of these transformers are all connected in series with each other and with the line. The receiver station contains a similar number of transformers, the primary coils of which are also connected in series with each other and with the line, while the secondary coils constitute as many distinct circuits. Each of these circuits contains a special relay in series and a condenser in parallel with the secondary circuit of the transformer. The relay is a mechanical resonance relay—that is to say, it contains a part which can vibrate, and the period of vibration of which coincides with the frequency of the current passing through it, so that the part vibrates and the relay acts only when a current of the same frequency is passing through it. This part can be simply a wire stretched between the poles of a magnet, or of an electromagnet, through which passes an alternating current. While vibrating, this wire can close a local circuit and produce suitable signals. Each condenser, on the contrary, placed in shunt on the secondary windings of the transformer, has such capacity that it constitutes an electromagnetic resonance circuit tuned for the frequency for which the relay is tuned. In this way the mechanical resonance and the electromagnetic resonance help each other in sorting out the the lines. It follows therefrom that, when several series of signals are sent currents on their arrival when several e.m.f.'s are simultaneously acting on through the line by simultaneously operating several manipulators, each relay produces those corresponding to the frequency for which it is doubly tuned, and receives only the message which is sent by the corresponding manipulator.

E. O. W

221. *Type-printing Telegraph.* (Elektrotechnik u. Maschinenbau, 24. p. 1082, Dec. 16, 1906.)—The method proposed by J. Huppert (Austrian Pat. 25,276) makes use of alternating currents of different frequencies. These currents are produced at the transmitter by means similar to that used in Mercadier's multiplex system; each frequency corresponds to one letter of the type. The receiver consists of a series of tongues, each capable of being started vibrating by a current of a definite frequency, as in Frahm's speed-counter. Each tongue, on vibrating sufficiently, makes a contact actuating its corresponding type on a printing-telegraph arrangement. To reduce the number of frequencies required, combinations of two or more frequencies may be made.

L. H. W

222. *Wireless Telegraphy: Influence of the Counterpoise on Damping.* **W. Burstyn.** (Elektrotechn. Zeitschr. 27. pp. 1117–1118, Nov. 29, 1906. Écl. Électr. 50. pp. 84–87, Jan. 5, 1907.)—The author discusses the effect of the resistance of the upper layers of the earth's surface in damping the oscillation of the conducting system formed by the aerial and counterpoise or lower capacity. It is assumed that the upper layer is bounded at a certain

depth by a water surface, as is practically the case in flat land or on a sandy shore. In deeper soil or rock a similar limit may be calculated from the depth of penetration of the alternating current. The quantities considered are: L, the inductance of the aerial; C, the capacity aerial to counterpoise; C_4, the capacity aerial to the ground water; C_3, the capacity counterpoise to earth's surface; C_2, the capacity earth's surface to ground water; and W, the resistance from earth's surface to ground water below the counterpoise. By means of a graphic method the relations between these quantities are worked out and an expression for the decrement obtained. In this expression the ratio of the height of the counterpoise above the earth's surface to the depth of the ground water occurs in the denominator. It is advantageous, therefore, to have this factor as large as possible, *i.e.*, to have the counterpoise as high as possible above the earth's surface, particularly if the ground water is at a considerable depth. The other variable quantities in the denominator are C_2/C_4, and C_1 (the other capacities in series). The first of these quantities is greater in proportion to the area of the counterpoise and in inverse proportion to the depth of the ground water. The second is great in proportion to the capacity between aerial and counterpoise. The actual damping due to this action may reach a large amount unless the lower capacity has a very large area; the author therefore concludes that unless the station is a temporary one or is built on hard, dry rock, it is more economical to employ a direct earth connection. [See also Abstract No. 1589 (1905).]

J. E.-M.

223. *Measurement of Received Energy at Wireless Telegraph Stations.* **G. W. Pickard.** (Elect. Rev., N.Y. 49. pp. 980–981, Dec. 15, 1906. Electrician, 58. pp. 494–495, Jan. 11, 1907. Écl. Électr. 50. pp. 214–216, Feb. 9, 1907.)—The author describes a rough method in which the discharge of a small condenser is balanced against the received signal. The condenser discharge is received on the same circuit and is arranged to have the same frequency as the received energy. Knowing the capacity of the condenser and the potential to which it is charged when balance is obtained, the energy can be calculated. The balance is obtained by judging the comparative intensity of a single dot on the telephone in the two measurements. The method of operation is fully dealt with, and some experimental results given. Any form of wave-detector can be used that responds to the r.m.s. value of the current. The author actually makes use of the carborundum coherer, which he assumes operates as a thermo-junction [see Abstract No. 96 (1907)], but the figures given do not agree with those of the earlier paper, the silicon-contact (carborundum) detector being now stated to give an audible signal with 450 micro-ergs in place of the 9,000–14,000 as previously stated. [Electrolytic detector, 864 micro-ergs.] L. H. W.

224. *Electric Radiation from Bent Antennæ.* **J. A. Fleming.** (Phil. Mag. 12. pp. 588–604, Dec., 1906. Paper read before the Physical Soc., Nov. 23, 1906. Electrician, 58. pp. 416–420, Dec. 28, 1906. Abstract. Écl. Électr. 50. pp. 141–148, Jan. 26, and pp. 175–176, Feb. 2, 1907.)—This paper is a description and discussion of some experiments on short bent antennæ, made in the courtyard of University College, London, for the author by G. B. Dyke. The antennæ used consisted of a couple of No. 16 bare copper wires loosely twisted together and from 10 to 20 ft. in length. On the grass of the courtyard some large sheets of zinc were laid down to form earth-plates. At one of these posts used as a transmitting station, a bent radiating

antenna was constructed by connecting one of a pair of spark-balls to the earth-plate and the other to a length of the copper wire which was so arranged that any fraction of its length could be placed vertical and the remainder horizontal. The free insulated farther end of the horizontal portion generally carried a plate of zinc 18 in. square, which served as an additional capacity. The wave detector was a fine constantan wire whose rise of temperature was observed by means of a tellurium-bismuth couple soldered to it, the whole being enclosed in a vacuum. The minimum r.m.s. current observable on this instrument was 800 microamps. No attempt was made to tune the receiving antenna to the transmitting antenna with any great exactness. The experiment consisted in placing the bent transmitting antenna at a certain distance from the fixed vertical receiver antenna and then swivelling round the horizontal part into various directions and taking readings of the current in the receiving antenna in each case. In the first set of experiments the sending antenna consisted of a double copper wire 20 ft. in length, having at the free end a terminal capacity plate, the wire being bent over at various heights from the ground or earthed end, so as to make a bent antenna with 1 ft. vertical and 19 horizontal or 2 ft. vertical and 18 horizontal, and so on. Observations were taken with a receiving antenna at the same distance, but at various angular positions round the transmitter. The currents in the receiver were plotted as radii vectores of a polar curve, and these radii were therefore proportional to the electric and magnetic fields at equal distances round its centre but in different azimuths. It can be seen from the curves given in the original that the greatest fore-and-aft inequality is obtained with this particular antenna bent so that 2 ft. of it is vertical and 18 horizontal, and that at the distance chosen, viz., 188 ft., the field in the direction in which the free end points is then about 60 per cent. of that in the opposite direction. The minimum is found at about 105° from the maximum. Other forms of antenna were tried, some of which consisted of a vertical portion with a horizontal part attached at various heights. The author expands the theory of these actions, as explained in an earlier paper [Abstract No. 2072A (1906)], and shows that experiment confirms the theory that the polar curve for an antenna with magnetic but no electric moment, viz., for a closed circuit, is a figure-of-8 shaped curve. The polar diagram for an antenna with electric but no magnetic moment, viz., for a vertical wire, is a circle. Experiments were also made with the outer part of the antenna extended at angles differing as much as 20° from the horizontal, which also confirmed the theoretical expectations. The similarly shaped polar curves given by Marconi for a bent receiving antenna are to be explained somewhat differently. They are due to the electric and magnetic force of the incident wave cutting, the vertical portion of the antenna with the added effect of the magnetic force lines passing under the horizontal part of the receiving antenna being alternately reversed in direction, aided by the wave-length being roughly 4 times the length of that wire. The total e.m.f. is the vector sum of these three separate e.m.f.'s. The numerical values of the first two are equal, and the third is proportional to the minimum radius of the polar curve in the direction 105° to 110°. J. E.-M.

225. *Improvements in Wireless Telegraph Transmitter and Receiver Arrangements.* (Elektrotechnik u. Maschinenbau, 24. pp. 1008, 1009, and 1010, Dec. 9, 1906.)—To avoid the short-circuiting of the source of current by the spark and also the inactive interval between sparks, Sahulka employs a rotating commutator by means of which one condenser is connected to such source of current

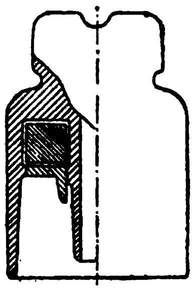
while a second condenser is connected to the oscillating circuit and discharging through it (Brit. Pat. 6,219 of 1906). The duration of the discharging connection is made large in comparison with that of charging. Braunerhjelm (D.R.-P. 178,854) points out that when an aerial system of length $1/4\lambda$ is employed there is a current node at the summit of the aerial. To obtain a better distant effect it is necessary to have a current of some considerable value at the summit of the aerial. He obtains this by using a network shorter than $1/4\lambda$ with a prolongation made of a single wire; this latter need not have any distant effect, and is hence placed within a built-up metal tube. The aerial proper is connected to the oscillating circuit and, through a spark-gap, to the prolongation in such a way that the current in the latter flows in the opposite direction to that in the former. Eisenstein's method (D.R.-P. 175,488, 176,011) consists in employing 3-phase current for supplying the primary or primaries of transformers so that a discharge is produced by each phase current in turn, thus reducing the inactive interval. [See also Elect. Engineering, 1. p. 258, Feb. 7, 1907.] A new form of single-contact coherer (devised by F. Braun), patented by the Gesell. f. drahtlose Telegraphie, consists of a flat surface of psilomelane (or pyrolusite, manganite, &c.) against which an iron point is screwed. The contact area should be $\frac{1}{4}$ mm.^{2} for $\frac{1}{2}$–1 volt from the local battery. If a different metal is used as connecting-wire to the screw no local battery is required (D.R.-P. 178,871).

L. H. W.

226. *Sustained Electrical Oscillations for Wireless Telegraphy.* (Electrical World, 49. pp. 101–102, Jan. 12, 1907. Elect. Engineering, 1. pp. 222–223, Jan. 31, 1907. Electrician, 58. p. 685, Feb. 15, 1907.)—These abstracts, from the specifications of F. K. Vreeland (U.S. Pats. 829,447, 829,934), show the principle of the method. A mercury vapour tube supplied with direct current is employed, the tube having a single mercury kathode and two metal anodes; the usual choking coils are put in the leads to these latter. The anodes are shunted by the oscillatory circuit, comprising capacity and inductance, the latter being in the form of coreless coils which are caused to act magnetically upon the vapour in the tube When the tube is started, by any of the usual means, the variable inequalities in the conductivity of the two vapour paths to the kathode are said to start irregular fluctuations in the tube which are sufficient to start the oscillations, after which the effect of the magnetic field due to the coils in the oscillating circuit is to feed energy into the shunt circuit in synchronism with the oscillations, by this means making up for the energy lost in radiation, &c. In the abstracts the explanation of the inventor that the action is due to the deflection of the current through the tube by the magnetic field is given, but in the specifications an alternative explanation, that it is due to the variation in the conductivity of the vapour caused by the field (which variation has been shown to take place by P. Cooper Hewitt), is advanced. A number of ways of connecting up for wireless telegraphy and for wireless telephony are shown; these present no new features. L. H. W.

227. *Combined Pupin Coil and Insulator.* (West. Electn. 39. p. 518, Dec. 29, 1906.)—To allow of easy spacing of the coils on overhead lines, and to protect them at the same time from the weather, the following device has been introduced. What is novel in this case is the combination of the porcelain insulator of the line with the coil itself, so as to contain the latter within the insulator. The drawing shows how this is carried

out so as to lodge both the Pupin coil and the resistance for the lightning-arrester, the latter being placed on the pole. An insulator is used of the single-petticoat form, and it is made with an annular chamber near the upper part. Coil and resistance are placed together and form a ring which fits into the chamber of the insulator, leaving a small clearance. Once in place a screw cap working upon the core of the insulator closes up the chamber at the bottom. Melted insulating matter is then run in around the coil through a hole in the cap, so as to hold it solidly in place and prevent any moisture from reaching the coil through the joint of the cap. By this method of construction the main body of the insulators remains in a single piece, and it is as strong and as easily made as an ordinary insulator. E. O. W.



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228. *High-speed Telegraph of Pollak and Virag.* **D. Korda.** (Soc. Int. Elect., Bull. 6. pp. 465–483, Dec., 1906. Écl. Électr. 49. pp. 486–492, Dec. 29, 1906, and 50. pp. 18–23, Jan. 5, 1907.)—This system is described in Abstract No. 821 (1901). This is a full account, with considerations of cost of operation in comparison with that of other well-known systems. The author calculates that, taking into account the expenses for lines, employés, and auxiliaries, the system of Pollak-Virag would be cheaper (where heavy traffics are dealt with) than the Morse, Hughes, and Baudot. E. O. W.

229. *Poulsen's Wireless Telegraph Transmitter.* (Elect. Engineering, 1. pp. 80–82, Jan. 10, 1907.)—The specification of V. Poulsen (No. 6,217 of 1906) is reproduced, showing the means employed for sending signals—either by re-striking the arc or by bringing the electrodes from a greater distance apart to exactly the distance required for correct signalling. [See also Abstract No. 1478 (1906).] L. H. W.

230. *Controlling Actions at a Distance by means of Electric Waves.* **E. Branly.** (Comptes Rendus, 143. pp. 585–587, Oct. 22, and pp. 676–678, Nov. 5, 1906. Electrician, 58. pp. 298-299, Dec. 7, 1906. Abstract. Électricien, 32. pp. 363–365, Dec. 8, 1906.)—A modified form of the author's apparatus is described [see Abstract No. 1061A (1905)], in which a step-by-step safety device is introduced. **L. H. Walter** (Electrician, 58. p. 342, Dec. 14, 1906) points out that the device is not novel, being identical with his own arrangement (Righi and Dessau, "Telegrafia senza Filo," 2nd ed., p. 485).

231. *Oscillation Valve or Audion.* **J. A. Fleming.** (Electrician, 58. p. 263, Nov. 30, 1906; and p. 464, Jan. 4, 1907. **L. de Forest.** (Ibid. p. 425, Dec. 28, 1906.) —Some controversial matter on the subject of the receiver lately described by de Forest [Abstract No. 1475 (1906)].

232. *Experiments on Directed Wireless Telegraphy.* **K. E. F. Schmidt.** (Phys. Zeitschr. 8. pp. 5–10, Jan. 1, 1907. Écl. Électr. 50. pp. 176–179, Feb. 2, 1907. Electrician, 58. pp. 605–606, Feb. 1, 1907. Abstract.)—The author describes further experiments with horizontal aerial wires [see Abstract No. 1257 (1906)]. The results are given in tabular form, and in the summary it is pointed out that the results differ very markedly from those obtained by Marconi. Since, however, in a later number (Ibid. p. 64, Jan. 15, 1907) the values in Table III. on p. 7 are corrected (0° should be 180° and 180° should be 0°) the original pages should be consulted with this correction in mind. L. H. W.

SCIENCE ABSTRACTS.

Section B.—ELECTRICAL ENGINEERING.

MARCH 1907.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

233. *Acceptance Tests on a 750-kw. Brown, Boveri-Parsons Turbo-Alternator.* (Zeitschr. ges. Turbinenwesen, 4. pp. 87–88, Jan. 30, 1907.)—This generating set has been in service at the Schlesische Coal and Coke Works at Cottesberg since September, 1906. Its rated output is 750 kw. at cos $\phi = 0{\cdot}8$. The steam consumption figures are as follows :—

Number of Test.	Load.	Duration of Test. Hours.	Steam Consumption in Kg. per Kw.-hour. Guaranteed.	Measured.	Vacuum.
I............	Rated load	1	8·8	8·0	90 per cent.
II.	Rated load	1	8·8	7·9	90 „
III..........	Half rated load	½	11·0	8·8	93·5 „

These figures correspond to a steam temperature of 300° C. and pressure of 8·5 metric atmos. abs. at admission. The steam consumption was determined by weighing the discharge from the air pump. *Speed Regulation.*—On throwing off and on full load of 750 kw. at 0·96 power-factor, the percentage change in speed observed was 5·5 and 3·7 per cent. (momentary), and 2·5 and 0·8 per cent. (permanent) respectively. *Pressure Regulation.*—Without adjustment of speed or excitation the permanent change in pressure was : On throwing off the load, 11·6 per cent. ; on throwing on the load, 8·5 per cent. The corresponding power-factor is not stated, but it was probably 0·96, as in the speed regulation tests. *Heating Tests.*—The temperature-increase of stator and rotor, corresponding to continuous operation at rated load of 750 kw. and 0·96 power-factor, were determined by resistance measurements, and it is merely stated that the results were well within the guarantee that the rules of the German Institution of Engineers should not be exceeded. As is well known, very high temperatures are permitted by these rules, and it is the boast of all first-class German manufacturers that their machinery never heats to any such

high temperatures as are permitted by these rules. One would infer that in the present instance the heating was well on towards these high temperatures, otherwise it seems likely that the figures would have been given. *Overload Tests.*—The machine operated perfectly satisfactorily for ½ hour with a 25 per cent. overload (952 kw. and $\cos \phi = 0{\cdot}84$). Surface condensing plant is employed. During the tests the slime from the bad cooling-water prevented the attainment of a high vacuum. Under good conditions a vacuum of some 94 per cent. will be obtained, and the steam consumption will be decreased to some 7·4 kg. per kw.-hour. H. M. H.

234. *Lentz Type Tandem Compound Steam Engine.* **K. H. Merk.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 144–147, Jan. 26, 1907.)—Describes the new Lentz tandem compound engines fitted with Lentz valve gear. These are now made in various sizes up to 1,000 h.p. The construction is exceedingly compact and very simple. The h.p. and l.p. cylinders are in a single casing, and have between them the Lentz packingless piston-rod seal. The two inlet valves of each cylinder are at the top, and the exhaust valves at the bottom. Between the h.p. and the l.p. cylinders the steam circulates in the jacket-receiver, the steam thus describing a horseshoe-shaped course. Illustrations are given of a 90-h.p. and a 900-h.p. engine of this type; a 8½-hour test on an intermediate size, having cylinders 870·7 and 611·0 mm. in diam., and a stroke of 450 mm., 202 r.p.m. showed (from the indicator diagrams) that the output from the front and rear end of the h.p. cylinder was 68·8 and 70·6 h.p., respectively, the corresponding figures for the l.p. being 56·5 and 49·6 h.p.; total 245·0 h.p., the steam consumption working out at 6·19 kg. (18·62 lbs.) per i.h.p.-hour. The mechanical efficiency, calculated from the switchboard readings of a dynamo driven by the engine, was 98 per cent. The chief advantages consist in the obtaining of all the qualities of a high-class engine—high efficiency, good regulation, reliability—while at the same time the engine is light in weight and occupies very little space compared with ordinary horizontal engines. L. H. W.

235. *Rotation Losses in Steam Turbines.* **H. Holzwarth.** (Power, 27. pp. 50–51, Jan., 1907.)—In horizontal turbines the friction in the journal bearings constitutes the "constant losses," and these depend upon the dead weight of the revolving part and the circumferential speed of the shaft, providing the design is good enough to obviate vibration. The "variable losses" comprise friction losses in thrust bearing; rotation losses in rotary part; throttling, whirl, eddy, and skin-friction losses of steam on its way through the vanes; leakage, radiation, and condensation losses of steam. The rotation losses are affected by the geometrical character of the parts of the rotor, whether smooth or interrupted; the same as regards the stationary envelope; the axial distance between rotor and envelope; the radial measurement of rotor parts from the centre; the angular velocity or r.p.m. of the rotor, and the density of the steam. Experiments are indicated which would be necessary for a full solution of the effects of all these elements, but from a number of isolated experiments with discs of different diam., vanes of different radial height, running at different speeds, general results show that these losses are proportional to the steam density, and that with smooth discs up to 50 in. diam., with vanes up to 2½ in. of radial length and covered by a band, and speeds up to 4,000 r.p.m. in steam of different densities, the rule, rotation loss in watts $= m \times$ abs. steam pressure in lbs. per sq. in., holds good within fair limits of accuracy. Six charts for ascertaining the value of the variable m,

under different conditions, accompany the paper. These charts or diagrams are formed on the three-axial system, and their use is explained by means of an example. [See also Abstract No. 108 (1907).] F. J. R.

236. *Economy of Steam Turbines and Piston Engines.* **F. Langen.** (Zeitschr. ges. Turbinenwesen, 4. pp. 1–6, Jan. 10, and pp. 27–30, Jan. 19, 1907.)—The writer has made a collection of the results of published tests on a very large number of steam turbines and piston engines. He has classified these results in groups relating to the different types of each class. It is pointed out that such work is attended with the greatest difficulty, since the steam consumption figures are by different engineers, variously quoted in i.h.p., effective h.p., kw.-hours, and so forth. Furthermore, the steam pressure is generally given in atmospheres, and there is frequently no statement as to whether the pressure above the atmosphere or the pressure above absolute vacuum is intended. The data as regards the degree of vacuum are sometimes given in cm. of mercury and sometimes in percentages of an atmosphere, and very frequently the corresponding barometric condition is not stated. There is thus thrown upon the compiler of data such as those contained in this article a great amount of work that would be unnecessary were rational conditions to prevail. The writer lays chief stress upon the thermodynamic efficiency,[1] and his average results from these tests are given in the following tables:—

		Average Rated Capacity in H.P.	Thermodynamic Efficiency.
Average thermodynamic efficiencies of 9 Piston Engines and 11 Steam Turbines. Conditions of operation: Saturated steam and non-condensing.	Piston Engine	196	60 per cent.
	Steam Turbine	60	57 "
Average thermodynamic efficiencies of 15 Piston Engines and 5 Steam Turbines. Conditions of operation: Superheated steam and non-condensing.	Piston Engine	197	74 "
	Steam Turbine	84	59 "

	Type.	Conditions of Test.	Number of Tests Averaged.	Average Rated Capacity in HP.	Thermo-dynamic Efficiency.
Thermodynamic efficiencies of Piston Engines of various types, operated condensing.	Single Cylinder	Sat. steam	1	115	43 per cent.
		Superheated	Not stated	84	43 "
	Compound	Sat. steam	21	390	60 "
		Superheated	28	308	61 "
	Triple expansion	Sat. steam	16	1,260	69 "
		Superheated	28	1,440	64 "
Thermodynamic efficiencies of Steam Turbines of various types, operated condensing.	Single pressure stage	Sat. steam	14	128	46 "
		Superheated	14	250	45 "
	Multi stage	Sat. steam	38	865	56 "
		Superheated	68	1,840	59 "

Present knowledge permits of designs of very appreciably greater efficiencies. In the case of working non-condensing and with superheated steam, the steam turbine is greatly inferior. For the other classes of work, however, the greater economy of the steam turbine as regards outlay for oil and attendance, and the lower first cost and greater compactness fully offset the inferiority as regards steam economy. The writer incidentally calls

[1] Thermodynamic efficiency here = "efficiency ratio" as adopted by the Inst. Civil Engineers, and is not the same as the over-all (thermal) efficiency.

attention to the circumstance that compound piston engines are at least the equal, as regards economy, of triple-expansion engines. Comparisons are also given of the use of exhaust steam for piston engines and for turbines. In this case the piston engine does not show up to anywhere near so great advantage as does the steam turbine. One plant by the Rateau Turbine Co. has given a thermodynamic efficiency of 72·5 per cent. for a 600-h.p. exhaust steam set. The writer finds the de Laval turbines to be greatly superior for small sizes, say up to 800 h.p. For mean ratings, say up to some 8,000 h.p., the Rateau and the A.E.G. turbines appear to give the best results, and he calls attention to a 1,500-h.p. Rateau turbine with an efficiency of 66 per cent., and a 1,720-h.p. A.E.G. turbine with an efficiency of 65 per cent. The Parsons turbine, on the contrary, although it has been the most widely adopted, appears less suitable as regards steam economy when employed for capacities below 2,000 h.p., as for these capacities it often shows thermodynamic efficiencies below 60 per cent., and this cannot be considered as satisfactory. Only at rated outputs of from 8,000 to 10,000 h.p. does it show thoroughly satisfactory results, and for this range of work it surpasses the efficiencies attained by the other types. It may in general be said that in order that the steam turbine shall compete with the piston engine it should show the following thermodynamic efficiencies: From 100–200 h.p., 50 per cent.; 200–1,000 h.p., 60 per cent.; 1,000–3,000 h.p., 65 per cent.; 3,000–6,000 h.p., 70 per cent.; 6,000–10,000 h.p., 74 per cent. The superiority of the steam turbine at the low pressure-ranges, and the superiority of the piston engine for high pressures and temperatures, leads to the conclusion that a combination of the two types of engine is conducive to the highest economy. With a compound machine of 5,000 h.p. for an admission pressure of 16 atmos. abs., and an admission temperature of 400° C., reheating between the cylinders, and some 2 atmos. abs. back pressure, an effective thermodynamic efficiency of some 90 per cent. should be obtained. The highest observed efficiency with steam turbines amounts to 74 per cent. Since the high-pressure stages, on account of the clearance losses, always work relatively unfavourably, a thermodynamic efficiency of 80 per cent. may be set as the attainable efficiency for a low-pressure turbine. Superheaters capable of working up to 500° C. have recently been available. Let us assume that the steam arrives at the machine with a temperature of 480° C., and is first employed in a reheater between the h.p. and l.p. cylinders of the piston engines. Let the steam next be admitted at 400° C. to the h.p. cylinder of the piston engine. Let the boiler pressure be 17 atmos. abs., and let the pressure at admission to the h.p. cylinder be 16 atmos. Let the steam emerge from the h.p. cylinder into the intermediate reheater at a pressure of 5 atmos. abs. Thus in the h.p. cylinder 85 heat units per kg. (kg.-cals.) have been liberated, and the temperature of the exhaust from the h.p. cylinder is some 310° C. Some 40 heat units per kg. are at our disposal for use in the reheater. The steam in the reheater will thereby be superheated to some 390° C., and will enter the l.p. cylinder at this temperature and at a pressure of 5 atmos. abs. The pressure between the piston engine and the turbine may be taken at 2 atmos. abs. Thus in the l.p. cylinder a further 60 heat units per kg. are liberated, and hence in the entire piston engine 145 heat units per kg.; consequently the temperature on admission to the turbine amounts to 270° C. Let the turbine work with a vacuum of 0·06 of an abs. atmo. In the turbine 147 heat units per kg. are liberated. The amount of heat transformed into work amounts to $(145 \times 0{\cdot}90) + (147 \times 0{\cdot}8) = 248$ heat units per kg., and the steam consumption (for the 10,000-h.p. set) $637/248 = 2{\cdot}57$ kg. per effective

h.p.-hour. At 97 per cent. efficiency of the dynamo this corresponds to 8·6 kg per kw.-hour, since 1 kg. of steam at a temperature of 500° C., and a pressure of 700 atmos. contains 829 heat units. With 75 per cent. boiler efficiency and with preheating of the feed-water to 100° C., there would be necessary for generation of steam (829–100)/0·75 = 972 heat units per kg. The coal consumption would amount to some 2·57 × 972/8000 = 0·318 kg. per effective h.p.-hour, and the over-all (or thermal) efficiency of the combination is 637/(2·57 × 972) = 25·5 per cent. This is about the maximum which is attainable with steam driving. H. M. H.

237. *Comparative Tests of Steam, Electric, and Hydraulic Mine Pumping Plants.* (Elektrotechn. Zeitschr. 28. pp. 203–204, Feb. 28, 1907. From Mitteil. über Forschungsarbeiten des Vereines Deutsch. Ing., No. 28.)—The full results of tests made jointly by the Verein für bergbaulichen Interessen and the Verein Deutscher Ingenieure, previously dealt with in Abstract No. 618 (1905). The chief data are given in the table and are self-explanatory :—

Mine.	Output. Water per min., cub. m.	Output. Height of Lift, m.	Type of Plant.	Steam Consumption per eff h.p.-hour kg.	Overall efficiency from admission of steam to discharge of water raised, per cent.
Victor	18·5	520	Steam, compound condensing, double plunger pumps......	11·02*	89·05
Dannenbaum	4·5	508·5	Hydraulic	10·541	65·58
Victor	7·5	500	Electric, high pressure centrifugal pumps......	10·07	58·79
Hansemann	5	488	Electric, with "express" pumps ...	9·525	69·68
Mansfeld (Colonia Pit)	4·7	484	Electric, with "Riedler express" pumps	6·91	68·47
Franziska ...	8·8	500	Electric, with slow-running pumps...	11·58	66·42

* Not including pipe losses in shaft.

L. H. W.

238. *Paterson Oil Eliminator and Water Softener.* (Engineering, 82. pp. 883, 884–885, Dec. 21, 1906.)—This apparatus, which is illustrated by a photograph showing a perspective view and by several sections, automatically supplies the proper proportion of chemicals for coagulating the emulsified oil in the condensation water, and for softening the make-up feed-water from a hard-water supply, and thereafter filters the treated water first through a wood fibre strainer and then through a bed of quartz sand [see Abstract No. 2118 (1904)]. The apparatus illustrated is capable of removing all trace of grease from 2,500 galls. per hour of condensed steam from surface condensers, and of softening 500 galls. of hard make-up water at the same time. Should the engine be run non-condensing or with a jet condenser, then the apparatus will soften 1,750 galls. per hour. The cost of the coagulant (which is an alumina salt) is approximately ¼d. per 1,000 galls treated, and for water of average hardness the cost of softening is approxi-

mately 1d. per 1,000 galls. The wood fibre requires renewal about once in six months, and the quartz filter-bed lasts an indefinite time, as it is periodically flushed to remove the muddy deposit, the process requiring about a quarter of an hour daily when running on full load. The feed is subject to a fall of from 2° to 5° F. in temperature only on passing through the apparatus.

F. J. R.

239. *Cost of Power as Generated by Different Types of Steam Engines.* **W. M. Wilson.** (Power, 27. pp. 12–16, Jan., 1907.)—In this article a rather elaborate investigation is described relating to a study of the cost of power for plants of various capacities ranging from 100 to 2,000 i.h.p. These cases are worked out for rated full load from the station for 10 hours per day for 310 days per year, and also for 24 hours per day for 365 days per year. The usefulness of the article is considerably impaired by the fact that during these hours the load is uniform at the rated capacity of the plant. On the other hand, the two cases may, in a sense, be regarded as contrasting plants with a station load-factor of $(10 \times 310)/(24 \times 365) = 0{\cdot}35$, with plants with a station load-factor of 1·00; although the conditions in the former case, as compared with irregularly loaded stations with the same load-factor (0·35) are exceedingly favourable to low costs. In each case one spare unit is installed. Considerable interest attaches to the various assumptions made by the writer. The cost of the building for horizontal engines and turbines was taken at $1.50 per sq. ft., and for the vertical engines at 11 cents per cub. ft. The sizes of engines employed were determined upon by the writer from consideration of the prices of the various engines. The cost of stacks was considered as constant for all sizes of plants and equal to $4 per boiler h.p., that of economisers at $5 per boiler h.p., and for steam piping at $5 per i.h.p. All prices relate to machinery installed complete with their foundations, and ready for operation. As regards economy of engines of various sizes, the writer plotted a series of curves for which the abscissæ were the sizes of the engines in i.h.p., and the ordinates represented the steam consumption in i.h.p. These curves showed that, for a given type of engine, the steam consumption per i.h.p.-hour was the same for all sizes of engines considered in the investigation, with the exception of the de Laval turbine. Consequently the choice of the size of engines for a plant in which the load is quite constant is, the writer concludes, determined by the initial cost of the plant. In determining the steam consumption of the different types of engines, the reports of a large number of engine tests were consulted; the corresponding consumption, at the pressures assumed for the different types of engines was determined by the use of Thurston's formula $H = \frac{a}{\log. p}$, where H is the number of B.Th.U. per i.h.p.-hour, which is to be determined, p is the pressure of the entering steam, and a a constant for the engine in question. The standing charges based upon the original cost of the plant were assumed to be 14 per cent. per year, and were made up as follows: Interest, 5 per cent.; depreciation, 5 per cent.; repairs, 2½ per cent.; insurance, ½ per cent; and taxes, 1 per cent. For the case of the use of the plant during only 10 hours per day and 310 days per year, coal is required for banking fires and getting up steam before the commencement of the 10-hour period that the plant is in operation. An allowance of 5 lbs. of coal per boiler h.p. per day has been allowed for this purpose. The results of the entire investigation are brought together in a series of curves, and are also given in a table, which is too bulky for reproduction except in part. The costs are given in dollars:—

Capacity of Plant, I.H.P.	Type of Engine.	Steam Pressure-Gauge.	Lbs. of Steam per 1 H.P.-Hr.	Size of Engines.	Total Initial Cost.	Interest, Depreciation, Repairs, Taxes, Insurance.	Continuous Expense per Year. Oil and Waste.	Attendance.	Condensing Water.	Coal. Upper Line 10-hr. Day. Lower Line 24-hr. Day. Cost of Coal per 2000 lbs. $5.00	Coal. Cost of Coal per 2000 lbs. $3.00	Total. Upper Line 10-hr. Day. Lower Line 24-hr. Day. Cost of Coal per 2000 lbs. $5.00	Total. Cost of Coal per 2000 lbs. $3.00
100	Simple Non-cond. h.s.	100	30	100	12956	1814	102	1559	—	3197	1918	6663	5384
							289	4380	—	8094	4814	14507	11297
	Compound Non-cond. h.s.	120	24	100	14136	1979	102	1550	—	2568	1540	6198	5171
							289	4380	—	6444	3867	13092	10514
	Compound Cond. h.s.	120	20	100	15233	2133	102	1550	193	2291	1374	6269	5352
							289	4380	546	5749	3449	13097	10797
	De Laval Turbine	120	18·6	100	14968	2061	102	1550	180	2183	1280	6046	5193
							289	4380	506	5348	3029	12806	10467
200	Simple Non-cond. h.s.	100	30	100	19275	2699	205	2170	—	6392	3836	11466	8910
							578	6182	—	16048	9628	25457	19067
	Compound Non-cond. h.s.	120	24	100	21133	2965	205	2170	—	5135	3081	10475	8421
							578	6132	—	12888	7733	22563	17408
	Compound Cond. h.s.	120	20	100	22733	3183	205	2170	387	4581	2748	10526	8693
							578	6132	1093	11498	6899	22484	17885
	De Laval Turbine	120	18·6	100	22151	3105	205	2170	360	4266	2559	10106	8399
							578	6132	1016	10696	6418	21527	17259
300	Simple Non-cond. h.s.	100	30	200	32212	4510	409	3026	—	12784	7671	20729	15616
							1156	8550	—	32096	19256	46312	33472
	Compound Non-cond. h.s.	120	24	200	34369	4812	409	3026	—	10269	6161	18516	14408
							1156	8550	—	25777	15466	40295	29984
	Compound Cond. h.s.	120	20	200	37398	5236	409	3026	773	9161	5497	18605	14941
							1156	8550	2187	22996	13798	40125	30927
	De Laval Turbine	120	17	200	36049	5047	409	3026	658	7795	4677	16985	13817
							1156	8550	1858	19552	11731	36163	28342
	Vertical Cond. l.s.	150	13	400	52287	7318	409	3026	503	5300	3180	16556	14436
							1156	8550	1421	13296	7978	31741	26423
	Hor. Cond. l.s.	150	13	400	51417	7198	409	3026	503	5300	3180	16436	14316
							1156	8550	1421	13296	7978	31621	26303
600	Simple Non-cond. h.s.	100	30	200	43950	6153	614	3813	—	19177	11506	29747	22076
							1734	10775	—	48144	28884	66796	47536
	Compound Non-cond. h.s.	120	24	200	45942	6432	614	3813	—	15404	9242	26263	20100
							1734	10775	—	38665	23199	57606	42140
	Compound Cond. h.s.	120	20	200	49886	6984	614	3813	1161	13733	8245	26305	20817
							1734	10775	3279	34494	20697	57266	43469
	De Laval Turbine	120	17	200	48300	6762	614	3813	986	11693	7016	23868	19191
							1734	10775	2788	29328	17597	51387	39656
	Vertical Cond. l.s.	150	13	300	69465	9725	614	3813	755	7950	4770	22857	19677
							1734	10775	2132	19945	11967	44311	36333
	Hor. Cond. l.s.	150	13	300	69490	9729	614	3813	755	7950	4770	22861	19681
							1734	10775	2132	19945	11967	44315	36337
	Parsons Turbine	150	13	600	60060	8408	614	3813	755	7950	4770	21540	18360
							1734	10775	2132	19945	11967	42994	35016
1200	Simple Non-cond h.s.	100	30	400	78306	10963	1227	5580	—	38353	23012	56123	40782
							3469	15768	—	96288	57768	126488	87968
	Compound Non-cond. h.s	120	24	400	79860	11180	1227	5580	—	30807	18485	48794	36472
							3469	15768	—	77331	46398	107748	76815
	Compound Cond. h.s.	120	20	400	85994	12039	1227	5580	2321	27465	16488	48632	37656
							3469	15768	6558	68989	41393	106823	79227
	De Laval Turbine	120	16·6	300	84240	11794	1227	5580	1925	22830	13699	43356	34225
							3469	15768	5440	57290	44374	93761	70845
	Vertical Cond. l.s.	150	13	600	106992	15249	1227	5580	1509	15900	9540	39465	33105
							3469	15768	4264	39890	23934	78640	62684
	Hor. Cond. l.s.	150	13	600	102530	14354	1227	5580	1509	15900	9540	38570	32210
							3469	15768	4264	39890	23934	77745	61789
	Parsons Turbine	150	13	1200	88090	12333	1227	5580	1509	15900	9540	36549	30169
							3469	15768	4264	39890	23934	75724	59763
2000	Vertical Cond. l.s.	150	13	500	155927	21830	2046	7440	2515	26500	15901	60331	49732
							5782	51025	7106	66483	39890	122225	95632
	Hor. Cond. l.s.	150	13	1000	148312	20764	2046	7440	2515	26500	15901	59265	48666
							5782	51025	7106	66483	39890	121159	94566
	Parsons Turbine	150	13	1000	122102	17094	2046	7440	2515	26500	15901	[illegible]	[illegible]
							5782	51025	7106	66483	39890	117480	90896

H. M. H.

240. *Efficiency of Boiler Plant.* **F. J. Rowan.** (Engineering, 82. p. 765, Dec. 7, 1906.)—Referring to the article dealt with in Abstract No. 5 (1907), Rowan points out that with an experimental water-tube boiler, designed in accordance with his own views as to the best conditions for heat transmission, he has obtained an evaporation of 12 lbs. per sq. ft. of generating surface with a total heat loss not exceeding 20 per cent. **J. H. Dales.** (Ibid. 83. pp. 10–11, Jan. 4, 1907.)—Dales quotes some of the tests of live-steam feed-heater with and without Green's economiser mentioned in G. Wilkinson's paper [see Abstract No. 1006 (1906)], and refers to a letter by Wilkinson (Ibid. 82. pp. 764–765, Dec. 7, 1906) contrasting live-steam feed-heaters external to the boiler with those placed in the steam space. The Harrogate tests showed a difference in favour of live-steam-heated feed of about 10 per cent. added heat economy over the economiser, the feed being supplied by the feed-heater to the boiler at a temperature of 10° F. below that of the boiler steam at full pressure. Such a result can be attained only when the gases held by the feed-water are thoroughly eliminated, and the writer maintains that the attainment of full steam temperature is physically impossible on account of the conditions of heat transmission. The heater used in the Harrogate trials was a Dales and Braithwaite "external" heater dealing with 14,400 lbs. of feed-water per hour, and the loss of heat by radiation is shown to have been $\frac{1}{17}$ per cent. of the coal consumed, or $\frac{3}{4}$ lb. of coal per hour. An internal form of feed-heater may prevent that loss, but creates a cold region in the boiler that destroys the essential condition for the economy which is due to hot feed, namely, the absence of any such comparatively cold region so that ebullition and evaporation can proceed from the whole of the heating surface. F. J. R.

241. *Fuel Economy of Heat-engines.* **W. Hort.** (Phys. Zeitschr. 8. pp. 55–68, Jan. 15, 1907.)—The author discusses the thermal efficiency of heat machines, and gives the results of his calculations in a series of striking diagrams. The following are the comparative figures obtained for the various engines expressed as kg.-cals. required per effective h.p.-hour, the h.p.-hour being taken as equivalent to 636 kg.-cals. :—

	Kg.-cals.		Kg.-cals.
1. Diesel oil engine (150 h.p.)	1,750	9. Lignite gas engine (500 h.p.)	4,000
2. Alcohol engine (25 h.p.)	2,200	10. Superheated steam engine (60 h.p.)	4,200
3. Illuminating gas engine (500 h.p.)	2,200	11. Triple-expansion steam engine (6,000 h.p.)	4,400
4. Producer gas engine (1,000 h.p.)	2,700	12. Steam turbine (5,000 h.p.)	4,400
5. Morgan gas engine (500 h.p.)	2,700	13. Marine steam engine (10,000 h.p.)	5,500
6. Benzine gas engine (25 h.p.)	2,700	14. Compound steam engine (200 h.p.)	5,600
7. Anthracite gas engine (500 h.p.)	2,900	15. Locomotive engine (1,000 h.p.)	7,000
8. Benzine gas engine (5 h.p.)	3,300		

In discussing the probable direction of future progress the author refers to the gas turbine, to the use of coal-dust in place of oil in the Diesel type of engine, and to the recovery of some of the waste heat of condensing water by use of a two-fluid engine, sulphurous acid being the most suitable fluid for the lower range of temperature. J. B. C. K.

242. *Temperley-Cockburn Boiler.* (Engineering, 83. pp. 176–178, Feb. 8, 1907. Mech. Eng. 19. pp. 286–288, March 2, 1907.)—The principle of this system consists in having in each horizontally-inclined water-tube in which steam is generated a small inner tube perforated on its upper surface and placed near the top inner surface of the water-tube, in order that the steam as formed in each tube may be drawn off at once to prevent a frothy mixture

of steam and water escaping. Combined with this is an arrangement for progressive heating of the feed in the water-tubes farthest from the fire, and an arrangement of air-jets at the front of the fire. These details are shown in an illustration applied to a Belleville boiler of the economiser type, and the acting of the steam-extracting pipes is shown by two illustrations of a glass model boiler. Trials carried out by Burstall and Monkhouse showed an efficiency of 76·1 per cent. in the case of a boiler of same ratio of heating to grate surface as that of the *Hyacinth's* boilers, the efficiency of the latter being 65 per cent. The system has been applied to Babcock-Wilcox boilers at the London Electric Supply Corporation, and has resulted in increased evaporation and efficiency. F. J. R.

243. *Single-acting Compound Steam Engines.* (Engineer, 103. p. 51, Jan. 11, 1907.)—This design, due to H. and A. T. Reid, J. Riekie, and J. E. Gibbs, provides sets of three cylinders connected to opposite cranks, one set being arranged immediately behind the other set. The cylinders are placed radially, two being high-pressure and one low-pressure. A cam-shaft with cams operates the valves of both h.p. cylinders, and another cam-shaft serves the l.p. cylinder, the admission and exhaust valves being separate. The two cam-shafts are driven in unison through gear wheels. Both h.p. cylinders exhaust ordinarily into the l.p. cylinder during one forward stroke of its piston, but the cam is so designed that for starting, the steam after following the first of the h.p. cylinder's full stroke, is allowed to pass direct into the l.p. cylinder. This ensures starting at any point and also enables full power to be developed at slow speed. One or more cylinders impart a fresh impulse to the crank at each $\frac{1}{6}$th of a revolution so as to provide a practically uniform torque (Brit. Pat. 26,114 of 1905). F. J. R.

244. *Injectors.* **P. Michel.** (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1944–1947, Dec. 1, 1906. Paper read before the Sächs.-Anhalt. Local Section. Bull. Soc. d'Encouragement, 108. pp. 1077–1082, Dec., 1906.)—The technical investigation of the steam turbine has established the conditions which regulate the issue of steam from nozzles, and the author makes use of the results of these researches in examining the conditions under which injectors work. Diagrams illustrate the action of jets under different conditions of pressure in the steam reservoir and in the external chamber, and the formula for the relation between these pressures is stated to be $p_1/p_2 = [2/(n+1)]^{\frac{n}{n+1}}$. With dry saturated steam and when the amount of heat does not change, $n = 1{\cdot}135$ and the relation $p_1/p_2 = 0{\cdot}5774$, or approximately $\frac{4}{7}$. To give increased velocity to the jet a conical nozzle is added, as in the de Laval turbine. A diagram of characteristic pressure-curves resulting from varied conditions of pressure and orifice is given. The question of velocity imparted to the water is investigated, and by means of a glass model it was found that in the mixing nozzle there was a mixture of steam and water, so that the specific weight of the fluid injected had to be taken account of. Experiments were carried out in apparatus represented by a diagrammatic sectional elevation, and a table gives numerous results with the different pressures of steam and water at various portions of the apparatus, and the velocities of steam and water calculated on the hypothesis (*a*) of homogeneous water in the mixing nozzle, and (*b*) on that of a mixture of steam and water. F. J. R.

GAS AND OIL ENGINES.

245. *Gas Turbines.* (Soc. Ing. Civ., France, Bull. 59. pp. 754–820, May, 1906. Discussion and Correspondence.) [For L. Sekutowicz's paper see Abstract No. 907 (1906).]—**R. Armengaud** described the gas turbine due to Lemale and himself [see Abstracts Nos. 26, 27 (1905)], and referred to Barbezat's method of representing the thermodynamic balance. **J. Rey** gave particulars of a compressor constructed by Sautter, Harlé et Cie for the Compagnie des Mines de Béthune, and designed to compress 2·2 lbs. of air per sec. (1,716 cub. ft. of free air per min.) to a pressure of 7·2 atmos. abs. (briefly described in Engineering, 82. pp. 600–601, Nov. 2, 1906). On trial it gave an output greater by 25 per cent., the speed being 4,500 r.p.m., and on increasing this speed the pressure of discharge was augmented by another atmo. The compressor consists of four distinct parts, each consisting of a group of 82 compressors arranged in series on one shaft, with a cooler intercalated between each successive pair of these groups; 400 h.p. was required to drive it. On the principle that all the frictional losses in that part of the machine between the two intercoolers concerned go to heat the air acted on and therefore to produce a temperature in excess of that due to adiabatic compression, the heat value of that rise of temperature was obtained from the sp. heat of air at constant pressure, giving thus in heat units the whole of the internal losses in that portion of the machine. The efficiency as thus ascertained was in the first part 70 per cent. and in the last 58 per cent., the mean for the four being about 68 per cent. In the high-pressure portion the losses from fan action and leakage are taken to account for the lower efficiency there. Assuming the efficiency of both turbine and compressor at 65 per cent. and the working pressure at 7 atmos., the compressor would require 88 per cent. of the whole output of the turbine to drive it. Further communications appear from **G. Hart, L. Letombe, A. Bochet,** and the reply of **Sekutowicz. F. Foster.** (Engineering, 82. p. 640, Nov. 9, 1906.)—In this letter Foster points out that because the internal losses during compression heat up the air, and, by increasing its volume, increase the amount of work necessary for compression, the efficiency, as calculated by the method used for the Béthune compressor, is too high. The efficiencies, when allowance has been made for the increase in the pressure-volume diagram, are 67·2, 62, 62·5, and 50·8 per cent., instead of 68·3, 68·5, 64·1, and 52·2 per cent. respectively. In addition to this, radiation losses must be allowed for, as these make the apparent rise of temperature, caused as above, to be much smaller than the actual rise. A loss of about half of the actual temperature-rise in the first cylinder would reduce its hydraulic efficiency from 67·2 to 48·5 per cent. Allowing also for mechanical efficiency, the efficiencies of the four cylinders cannot have been much above 55, 50, 50, and 40 per cent. respectively, and were probably below these figures. F. J. R.

246. *Gas Turbines.* **F. Foster.** (Mech. Eng. 18. pp. 790–792, Dec. 8; and pp. 824–828, Dec. 15, 1906.)—On the basis of the use of turbo-compressors referred to in the papers dealt with in the preceding Abstract, the author shows that with the four-stage compressor with intercoolers and a turbine efficiency of 0·6, the net efficiency of the combination is 8·8 per cent. If no intercoolers were used the efficiency would drop to 0, or even become negative, in the case where expansion is carried to 14·88 lbs. per sq. in. By expanding below atmospheric pressure somewhat higher theoretical efficiencies could be obtained, combustion taking place at con-

stant pressure. The combustion-chamber lining of Armengaud and Lemale is described and illustrated. On the subject of cold injections, the use of cold air is considered, but the compressor is a bar to the use of cold air in any practical quantity. Water injection reduces the efficiency of the turbine, and given an efficient compressor, cold air would be in every way superior. Injecting steam into the hot gases is considered, and one form of steam generator is illustrated. *Type of turbine.*—The reaction type is unsuitable, the Curtis possesses advantages from a mechanical point of view, but if run at its most efficient speed the de Laval has the highest efficiency. The 300-600-h.p. gas turbine of Armengaud and Lemale, of Curtis type with Rateau turbo-compressor, running at 4,000 r.p.m. is described. The combustion chamber and petrol burner are illustrated in section, and also a method of cooling the turbine blades. *Thermal Types.*—The Brayton or constant-pressure cycle is generally considered preferable, but the Otto cycle has some advantages. Nordenfeld's proposed turbine on the latter cycle, but without initial compression, is illustrated by a diagram. In order to expand the gases below atmospheric pressure an ejector compressor is used, which also compresses them and ejects them into the atmosphere. A diagram of this arrangement is given and a work diagram, with the method of calculation. *Binary turbines* are illustrated diagrammatically, and the employment of *regenerators* is carefully studied. Two tables are added to assist in making gas-turbine calculations for atmospheric back-pressure: I. for Brayton cycle calculations, and II. for expansion of air to atmospheric pressure. In Table I. p = combustion pressure in lbs. per sq. in., abs., being taken from 400 down to 25; C = work done in B.Th.U. by compressor from 197 to 20·8; E = network done by turbine in B.Th.U. per 100 B.Th.U. added during combustion, 68 to 18·9; and r = ratio of gross turbine work to compressor work, or E + C/C, 1·320 to 1·685. In Table II. p = abs. inititial pressure, 250 to 30 lbs. per sq. in.; D = discharge of least section of nozzle, 5·965 to 0·715 lbs. per sq. in.; W = kinetic energy in outflowing air, 66·2 to 22·2 B.Th.U. per lb.; and v = velocity of outflow ($= 223·8\sqrt{W}$ ft. per sec.), 1,820 to 1,052. In *experimental results* reference is made to Lucke's experiments with a de Laval turbine with cold air [see Abstract No. 1014 (1906)], and to others carried out at Sibley College. A diagram of results obtained by Armengaud and Lemale with a de Laval turbine run as a gas turbine concludes the paper. F. J. R.

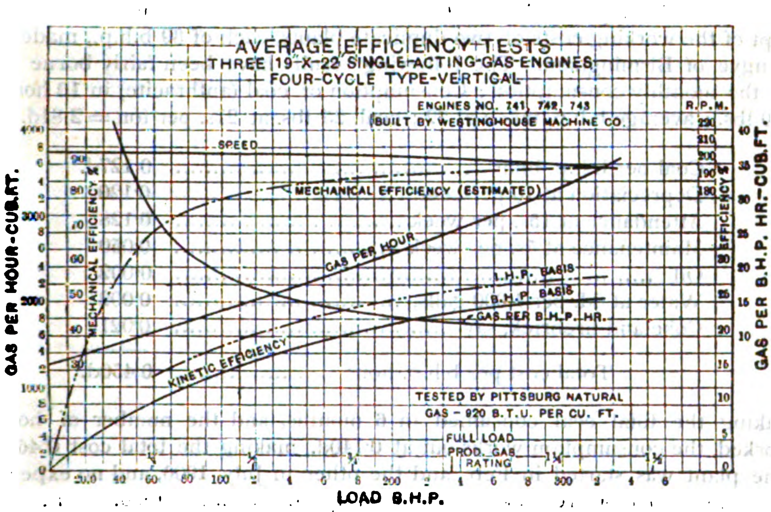
247. *Gas Turbines.* **R. Armengaud.** (Cassier, 31. pp. 187–198, Jan., 1907.)—The author divides gas turbines into three groups, viz., hot-air, explosion, and combustion turbines. The first is represented by the turbine of Stolze, in which air is compressed to about 1¼ atmos. in a helicoidal compressor, heated by circulating about a furnace, and then admitted to a turbine attached to the same shaft as the compressor. A diagrammatic section of the explosion turbine first used by the author and Lemale, and a diagram showing the variations in pressure are given. The max. pressure reached 30 to 45 lbs. per sq. in., which was considerably short of the theoretical. All his later experiments have been made with the continuous combustion type, and illustrations are given of one of 400 to 800 h.p., running at 4,000 r.p.m. This machine is operating in the shops of the Société des Turbomoteurs at Paris. Its design is also illustrated by a diagrammatic section, and various details are also shown. [See preceding Abstract.] The compressor, of which an illustration is given, is the polycellular turbo-compressor of Rateau and Armengaud. [Abstract No. 245 (1907).] A heat balancer

diagram of this turbine is given, and also economy curves, which show that with a pressure of 30 kg. per cm.[2] and an exhaust temperature of 450° C., an efficiency of 18 per cent. is obtained, the efficiency of the turbine wheel being taken at 60 per cent. and the compressor at 80 per cent. The speed regulation is effected by throttling the air admission for small speed-variations, and by a change in the fuel supply for larger changes, the regulating valves being controlled by a Hartung governor. [See also Abstract No. 907 (1906).] F. J. R.

248. 100-*H.P.* "*Ruston*" *Suction Gas Producer and Engine.* (Engineering, 82. pp. 835 and 836, Dec. 21, 1906.)—This producer and engine are made by Ruston, Proctor and Co., Ltd., of Lincoln, and are illustrated in elevation and section. The engine is of the horizontal, single-cylinder, four-stroke cycle type, with valves moving vertically. Both the piston and the exhaust-valve are water-cooled, and the ignition is adjustable whilst the engine is working. A low-tension magneto is used for the ignition, and the governing is by the hit-and-miss system, a very sensitive centrifugal ball governor cutting out the charges when the speed exceeds the normal. Ring lubrication is used for the main bearings, and for the crank-pin a continuous, centrifugal oiling ring. Forced lubrication is provided for the piston. The producer has the usual features of suction plant with a three-way cock placed in the connecting pipe between generator and scrubber. F. J. R.

249. *Producer-Gas Power Plant.* J. R. Bibbins. (Amer. Soc. Mech. Engin., Proc. 28. pp. 197–220, Nov.; Discussion, pp. 879–880, Dec., 1906. Abstracts in Eng. News, 56. pp. 616–617, Dec. 13, 1906. Electrician, 58. pp. 486–489, Jan. 11, 1907.)—Two factories (one of them including a large steel foundry) of the Gould Manufacturing Co., at Depew, a suburb of Buffalo, N.Y., are electrically driven and lighted from the central gas power plant described and illustrated in this paper. The power plant comprises two producer units of the Loomis-Pettibone, duplex, intermittent, blast type, for bituminous coal, with cleaning plant consisting of wet and dry scrubbers, gas-holder, Roots' exhauster and small vertical boiler; gas main of 12-in. diam. with 8-in. risers to engines; 3 Westinghouse, 3-cylinder, vertical, single-acting, 4-cycle engines with cylinders 19 in. diam., 22 in. stroke, 200 r.p.m., of capacity 235 to 260 (max.) b.h.p., furnished with both high- and low-tension electric ignition (operated by 8-volt storage batteries and by a $\frac{1}{2}$-kw. 110-volt motor-generator), and Westinghouse, compound-wound, continuous-current generators, direct-coupled to engines, having each a capacity of 150 kw. at 250 volts. A table of full details of the equipment data is given; and also additional tables showing a typical 24 hours log, operating data for 10 days, approximate power costs, engine efficiency, and characteristics of the power gas. There are also charts of 4 typical day runs, and diagrams showing relation of fuel rate to load-factor; fuel combustion at various outputs; average plant duty at various load-factors; relative power costs at various load-factors and average engine efficiency, plotted as curves; and some cylinder indicator cards. This plant is continuously running 24 hours per day for $6\frac{1}{2}$ days per week on a fluctuating manufacturing load, consuming, on an average of $\frac{1}{2}$-load, from 2 to $2\frac{1}{2}$ lbs. coal per kw.-hour, and on heavier loads has reached a consumption of $1\frac{1}{2}$ lbs. During heavy loads the output has reached 530 kw. on maximum fluctuations representing an overload of 18 per cent. rating. During the 10-days' run recorded in Table 3, the engines averaged $87\frac{1}{2}$ per cent. of the possible running time,

and on 54 per cent. station-loading factor the plant consumed 2·04 lbs. fuel per kw.-hour, or 1·44 lbs. per b.h.p.-hour. With coal of 13,500 B.Th.U. the plant efficiency averages about 13·1 per cent., and on one day the fuel rate being 1·88 lbs. per kw.-hour (or about 1·25 lbs. per b.h.p.-hour) with 62 per cent. load-factor the efficiency was over 15 per cent. Some better results are added in a note. The average fuel consumption at various outputs, when plotted, is approximately a straight line within observed limits, and the average fuel per kw.-hour forms approximately a rectangular hyperbola within normal ranges of load. The average engine efficiency is shown in the accompanying diagram. From these data the producer-plant efficiency is deduced. At 50 per cent. load-factor the average plant efficiency is 12 per cent., that of the engines is approximately 17 per cent., and the producer



plant slightly above 70 per cent. At 75 per cent. load-factor the average plant efficiency is 18 per cent., engines 20 per cent., and producers 65 per cent. During a specially good day's run the efficiencies were: Plant 15, engines 21, producers, 71·5 per cent. The approximate power costs are as follows:—

	Minimum.	Normal.	Maximum.
Output, kw.-hours per day	5,000	8,000	10,000
Fuel, cents per kw.-hour	0·25	0·22	0·20
Labour	0·28	0·17	0·14
Supplies and repairs (estimated)	0·17	0·13	0·11
Operating costs, cents per kw.-hour	0·70	0·52	0·45
Fixed charges	0·45	0·28	0·22
Total costs, cents per kw.-hour	1·15 (0·57d.)	0·80 (0·4d.)	0·67 (0·33d.)

The relation of fixed and working costs to the station load-factor is shown in diagram form, which illustrates how rapidly fixed charges and labour increase with light loads, *e.g.*, the total cost of power is halved by increasing the load-factor from 24 to 55 per cent. The average composition of the mixed air- and water-gas is shown to be: H, 9·81; CO, 21·9; CH_4, 2·05;

O_2 0·5; CO_2, 6·05; N, 59·9 per cent.; average calorific value, 100 B.Th.U. per cub. ft. The producer plant is worked by two men per shift, and the engines by one engineer and an oiler per shift. Additional labour is usually required on Sundays for cleaning. In the *discussion*, **W. D. Ennis** referred to a supposed error in the area of the power building (mistaking the areas in the second column, which are cooling-pond areas), and stated that the Summer Lane Station at Manchester occupies 2·45 sq. ft. per kw., the plant containing both turbines and reciprocating engines, and that of the West Jersey and Seashore Railway uses 2·18 sq. ft. per kw. F. J. R.

250. *Working of Suction Gas Plant.* **A. J. Stevens.** (Electrician, 58. pp. 539–540, Jan. 18, 1907. Abstract of paper from South Wales Inst. of Engineers, Proc., Jan. 9, 1907.)—Continuous records, for over 6 months, were kept of the working costs of two duplicate plants, each of 39 b.h.p., made by Tangye, of Birmingham. The following results have been fairly borne out by the monthly consumption: Consumption of coal (anthracite) in 10 hours, 250 lbs.; average b.h.p. taken at 22; coal, 25 lbs. at 21s. per ton = 2·81d.:—

Coal per b.h.p.-hour	0·127d.
Depreciation at 10 per cent.	0·120
Attendance at 15s. per week	0·128
Maintenance at 5s. per week	0·050
Oil	0·002
Water at 8d. per 1,000 galls.	0·002
Coke and firebrick, say	0·021
Total cost per b.h.p.-hour	0·450d.

Taking the total coal consumed in 6 months, and the number of hours worked, the consumption works out at 0·140d., making the total cost 0·463d. One plant was started in Feb., and the other in July, 1906, and no expense for maintenance or firebrick was incurred up till the end of 1906. F. J. R.

251. *Suction Gas Producers.* **A. Scherhag.** (Gasmotorentechnik, 6. pp. 154–158, Jan., 1907.)—The author discusses the thermal efficiency of suction gas producers, under various conditions as regards the temperature and moisture of the incoming air. The percentages of carbonic oxide and of hydrogen in the gas obtained from the producer, vary inversely according to the amount of moisture in the air supply, and this depends upon the temperature at which the producer is working. With a high temperature a gas rich in hydrogen (33·4 per cent.) will be obtained, while with a low temperature a gas containing only 10 per cent. of hydrogen is produced. The carbonic oxide contents of the gas likewise vary between 33·4 per cent. and 47 per cent., the percentage being lightest when the producer is worked at a low temperature. The thermal efficiency of the producer in the first case is 78 per cent., as against 86 per cent. in the second. The average working efficiency of this type of producer is about 80 per cent. The chief advantage of the suction type of gas producer as compared with the older form, is that the heat carried away by the escaping gases is retained and made to do useful work in the vaporiser of the apparatus. The temperature of the moisture-laden air obtained from this portion of the apparatus varies between 52° and 76° C. A temperature in excess of 76° C. will only lead to loss of heat, since too much moisture will then be carried into the generator. Even

when using anthracite or coke, the suction gas-producer has proved its ability to compete with the ordinary steam boiler and engine for the generation of power. Since this type of producer has been modified to allow of the use of bituminous fuel, its great superiority to the older form of power plant, in cost, is undoubted, and its field of usefulness is widely extended. J. B. C. K.

252. *Efficiency Tests on a High-speed Petrol Motor.* B. Hopkinson. (Engineering, 83. pp. 164–166, Feb. 8, 1907.)—The engine was a Daimler four-cylinder motor-car engine, rated at 16 to 20 h.p. and capable of being worked at 250 to 1,400 r.p.m. Total vol. of 1 cylinder with piston at out-centre, 0·04 cub. ft. Vol. of compression space, 0·0104 cub. ft. Compression ratio, 3·85. Diam. of cylinder, 3·56 in. Length of stroke, 5·11 in. Indicator used was of the optical type designed by the author, having a piston working against the middle of a straight steel spring held at both ends. The deflection of the spring turns a mirror and the spot of light was projected on to a transparent graduated screen. Some specimens of the photographs taken to show the diagrams are given. One cylinder was indicated at different speeds, the other 3 cylinders running idle and no load on the engine, to determine mechanical losses. Curves show the i.h.p. required to drive the engine in this way and the i.h.p. lost in pumping and compressing, also the mechanical efficiency or the ratio of b.h.p. and i.h.p. ordinates plotted in terms of speed, in one diagram, and in another the b.h.p. obtained by running with the throttle-regulator kept open and the ignition timed till the power on brake was a maximum at the speed. Mean effective pressure and torque are also similarly represented. The petrol was tested for calorific value and taken at 17,500 B.Th.U. per lb. On that basis the petrol consumption and thermal efficiency found in a number of tests at different speeds are given in the following table :—

Speed.	Petrol Consumption (Pounds).			Thermal Efficiency.	
Revs. per min.	Per I.H.P.-hour.	Per B.H.P.-hour.	Per 1,000 revs.	On I.H.P.	On B.H.P.
400	0·78	0·9	0·30	18·6	16·1
400	0·75	0·87	0·28	19·3	16·6
600	0·685	0·81	0·26	21	17·9
600	0·655	0·77	0·24	22	18·8
800	—	—	0·24	—	—
1,000	0·6	0·75	0·22	24·2	19·3
1,000	0·6	0·75	0·206	24·2	19·3
1,100	0·59	0·785	0·202	24·6	18·4
1,225	(0·65)	0·94	0·22	(22·3)	15·4

NOTE.—At speeds 400, 600, and 1,000, two tests are given to show the range of variation. At 1,225 the i.h.p. is uncertain, as no direct measurement of loss was made at that speed.

The efficiency at each speed is not necessarily the best possible, because although the amount of mixture of air and petrol taken per stroke was controlled by the throttle, the composition of the mixture or proportions of petrol vapour and air was not under control, and with a higher strength of mixture better results might follow. Comparing this engine with a gas engine at the Engineering Laboratory of Cambridge University it was found that the Daimler engine at 24½ per cent. efficiency was doing one-fifth more work for the same fuel. F. J. R.

253. *Influence of the Carburettor Jet on the Mixture Ratio in Petrol Motors.* **K. Rummel.** (Motorwagen, 9. pp. 705–709, Sept. 30; 753–758, Oct. 20; 786–798, Oct. 31; 928–932, Nov. 30; 1020–1024, Dec. 31, 1906, and 10. pp. 20–23, Jan. 20, and pp. 52–55, Jan. 31, 1907.)—A lengthy theoretical and experimental investigation carried out to test the author's theory that friction of the liquid combustible in tubes of very fine bore has considerable effect in producing the inequalities in the mixture ratio. It is concluded that this hitherto neglected factor, the internal friction of the fuel, is very important indeed with small jets; and this effect, together with that due to the varying differences in level between the liquid in the jet and the jet supply, accounts satisfactorily for the phenomena which are observed. L. H. W.

254. *High-tension Electric Ignition for Petrol Engines.* **J. A. Davenport.** (Engineering, 83. pp. 228–229, Feb. 22, 1907.)—Describes tests carried out upon a 4-h.p. Fafnir single-cylinder engine, fitted with a Sthenos carburettor. The only factors which were varied were the high-tension sparking-gap and the voltage. Experiments were conducted at 4 volts pressure, and at 2 volts. A cheap form of sparking-plug was used, and the length of the gap measured by graduated feelers. Several series of tests were made, and the results are given both in the form of tables and as comparative curves. So far as the tests go they show that for the coil used the best spark-gap is about 0·030 in. Equally good results were found at the lower pressure, the consumptions of petrol being identical, and the author questions the standard practice of using 4 volts. W. P. D.

AUTOMOBILISM.[1]

255. *Comparative Test of Alcohol, Kerosene and Gasoline as Fuel for Automobiles.* (Scientific American, 96. p. 127, Feb. 9, 1907. Motorwagen, 10. pp. 176–177, March 10, 1907.)—An account of an automobile run from New York to Boston under the supervision of the Automobile Club of America and the American Automobile Association. The cars employed were three identical Maxwell touring cars with double opposed cylinders 5 in. diam. × 5 in. stroke. About 1 ft. of snow was on the ground. The fuel consumption of the three cars, which ran with gasoline, kerosene and alcohol (denatured), for the 250-mile journey was respectively 24¾, 33¾, and 40¾ galls. At the prevailing prices in America (20, 18, and 37 cents per gall.) the respective costs per ton-mile work out at 1.69, 1.39, and 4.48 cents, or per car-mile 1.9, 1.75, and 6.03 cents. The weights of the cars were 2,270, 2,520, and 2,750 lbs. respectively, when loaded. In order to be on a par with gasoline at 20 cents, alcohol should hence be purchasable at 22 cents per gall. and be used in a specially constructed engine (higher compression and longer stroke) by which the 10 per cent. increased efficiency obtainable from alcohol can actually be realised. L. H. W.

256. *Screw Propellers and a Comparison of Helicoplanes and Aeroplanes.* **P. Tsoucalas and J. Vlahavas.** (Comptes Rendus, 144. pp. 125–128, Jan. 21 (extract), and pp. 257–259, Feb. 4, 1907.)—(1) *Air resistance.*—The resistance normal to the moving plane of surface s (taken as being small and polished) having a velocity v in a direction making an angle ϕ with the plane $= k = fs\sin^2\phi v^2$, that is = that component of the total resistance which is normal to the plane. The coefficient f has been experimentally found by the

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

authors to have the values 0·16, 0·11, and 0·07 for normal incidence, incidence at 45° and at 30° respectively. (2) *Screw propellers.*—A formula is arrived at for the maximum absolute thrust (Z) developed by a fixed screw, in the direction of the axis of rotation, for a given power T and blade surface S (in the case of a vertical screw the maximum lifting force), viz., $Z = 0{\cdot}874 \sqrt[3]{fST^2}$...(1). A table is given showing the coefficients for the most suitable angles of pitch of the helix. In the second part a comparison is instituted between the helicoplane (screw with axis vertical) and the aeroplane (screw with axis horizontal). Equation (1) has already given Z for the case of the vertical screw. For the case of the horizontal screw $Z = 0{\cdot}187 \sqrt[3]{fST^2}$, hence the lifting force of the aeroplane is but half that of the helicoplane for the same applied power and the same screw. The latter can also dispense with sustaining planes, which are always a menace to the stability. Taking then the air-resistance of the car and machinery to be 10 per cent. of that of the aeroplane, the total power required to obtain with a helicoplane the same lifting force and the same translational movement as with an aeroplane, is only 0·057 of that required by the latter, or less than 6 per cent. L. H. W.

REFERENCES.

257. *Effects of Superheating as applied to Reciprocating Engines and Steam Turbines.* **P. Martinet.** (Bull. Technologique, No. 9. pp. 720–738, Sept., 1906.) —Considerations illustrated by entropy diagrams.

258. *Thermodynamics of the Steam Turbine.* **P. Martinet.** (Bull. Technologique, No. 11. pp. 787–811, Nov., 1906.)—A complete graphical calculation for a 300-h.p. 3,000-r.p.m. action turbine with a single pressure-stage is carried out in this paper.

259. *Steam-engine Theory.* **W. Schüle.** (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1900–1907, Nov. 24; 1934–1940, Dec. 1, and pp. 1988–1992, Dec. 8, 1906. Paper read before the Breslau Local Section, Dec. 15, 1905.)—This paper gives first a brief historical summary, and then a general theory is developed by elaborate mathematics with the aid of many diagrams, special attention being paid to steam-flow and governing. [See also Abstract No. 1445 (1904).] A. W.

260. *Steam.* (Engineering, 83. pp. 1–2, Jan. 4, and pp. 40–41, Jan. 11, 1907.)—An article on steam founded on the saturation-pressures determined by the de Laval Steam Turbine Co. and the assumption of a parabolic trend of the latent heat [though the numbers given do not lie on a parabola] with zero-value at 698° F. R. E. B.

261. *Steam Boilers in Electricity Works in London.* **R. Lind.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 54–62, Jan. 12, 1907.)—A table and collected information relating to the number, type, and capacity of boilers in the various electrical power stations.

262. *Smoke Prevention in the Power-house.* **C. H. Benjamin.** (Cassier, 31. pp. 339–352, Feb., 1907.)—The author advocates the employment of mechanical stokers and gives illustrations of installations of inclined-grate, chain-grate, and under-feed stokers in various American works, and of Bennis and Wilkinson stokers applied elsewhere. He thinks the use of stokers should be made compulsory in order to prevent smoke. F. J. R.

263. *Rotary Engines.* **W. Gentsch.** (Verein zur Beförd. des Gewerbefleisses, Verh. No. 8. pp. 363–399, Oct.; 9. pp. 417–440, Nov., and 10. pp. 465–486, Dec., 1906.) —Reviews the more promising types.

264. *Comparison of certain South African Coals.* **F. A. D. Moseley.** (Engineer, 103. p. 145, Feb. 8, 1907. Paper read before the Transvaal Inst. of Mech. Engin.)—The author's test results, made with the Mahler bomb for calorific value, are given for a number of Natal and Transvaal coals, and are compared with the Natal Government values obtained with the Thomson calorimeter. L. H. W.

265. *Gas-turbine Compressor.* **A. Barbezat.** (Zeitschr. ges. Turbinwesen, 3. pp. 521–527, Dec. 29, 1906. From Schweiz. Bauzeitung, Nov. 17, 1906. Zeitschr. Vereines Deutsch. Ing. 51. pp. 35–37, Jan. 5, 1907.)—A description of the testing of a centrifugal compressor [referred to by Rey, see Abstracts Nos. 245, 247 (1907)] which the Société des Turbomoteurs à combustion has had built from designs by Rateau for operation by an Armengaud-Lemale gas turbine. The results obtained are compared with those of an ordinary piston compressor. A. W.

266. *Six-cylinder Engines* v. *Four-cylinder Engines.* (Automobile Club Journ. 13. pp. 153–161, Feb. 14, 1907. Discussion. Automotor Journ. 12. pp. 217–218, Feb. 16, 1907.)—S. F. Edge showed diagrams obtained in tests carried out by W. Duddell for O'Gorman and Cozens-Hardy with a 6-cylinder 40-h.p. Napier car and a 35–45-h.p. Renault car. The vertical, lateral, and longitudinal vibrations at different speeds are shown (obtained with apparatus sketched in Automotor Journ. 12. p. 218, Feb. 16) and generally confirm what would be expected from the known types of torque-diagram [see Abstract No. 280 (1906)]. L. H. W.

267. *New Forms of Construction in Magneto-ignition Devices.* **W. Wolf.** (Motorwagen, 9. pp. 953–957, Dec. 10; 987–991, Dec. 20, and pp. 1028–1032, Dec. 31, 1906.)—The types dealt with are exclusively of German origin, and the chief aim appears to be the obtaining of a flat-topped wave of e.m.f.

268. *Screw Propellers for Airships.* **F. Ferber.** (Comptes Rendus, 144. pp. 128–130, Jan. 21, 1907.)—By introducing into Renard's expressions for the pressure exerted, and power required by screws as a function of their diam. and speed of rotation [see Abstract No. 446 (1904)], a factor for the relative recoil, dependent on the pitch of the screw, the author arrives at formulæ in which the coefficients whose values are to be found experimentally do not include this factor; hence these coefficients can be determined by measurements made with a captive (fixed) machine. In this way it is considered that an airship can be designed with considerable accuracy in advance of its construction. L. H. W.

269. *Aeroplanes and Propellers.* **P. Alexander.** (Automotor Journ. 11. pp. 1765–1767, Dec. 29, 1906. *Résumé* of paper read before the Aero Club.)—Various points dealing with the design of propellers and the behaviour of surfaces of different shapes when exposed to air currents are touched upon.

270. *Parseval Dirigible Airship.* **A. Gradenwitz.** (Scientific American, 95. pp. 341–342, Nov. 10, 1906.)—Illustrated.

271. *Stability of Aeroplanes.* **E. Seux.** (Comptes Rendus, 144. pp. 73–74, Jan. 14, 1907. Extract by the Commission d'Aéronautique.)—Further considerations in which the fact that there is a considerable thickness at the forward edge of a bird's wing is experimentally applied to the case of an aeroplane [see Abstract No. 155 (1906)].

INDUSTRIAL ELECTRO-CHEMISTRY, GENERAL ELECTRICAL ENGINEERING, AND PROPERTIES AND TREATMENT OF MATERIALS.

272. *Aluminium Chloride as Auxiliary Depolariser for Galvanic Cells.* (Brit. Pat. 284 of 1906. Centralblatt Accumulatoren, 8. p. 22, Feb. 5, 1907. Abstract.)—H. A. E. W. L. Femerling and F. W. Pörscke recommend the mixture of from 10 to 40 parts of crystallised $AlCl_3$, with from 15 to 20 per cent. graphite or coke, and about 50 of powdered manganese peroxide. The aluminium chloride does not attack zinc, the negative electrode, which may also be made of iron, cadmium, magnesium, aluminium. For dry cells, a paste is prepared of a solution of aluminium chloride of 25 or 30 per cent., and from 5 to 10 per cent. (of the $AlCl_3$) of magnesia; the paste conducts well and does not liquefy when hot; as it shrinks, it should be made in a separate vessel. H. B.

273. *Electrolytic Production of Chromic Acid.* (Brit. Pat. 27,009 of 1905.)—In the process patented by the Badische Anilin and Soda Fabrik, chromic acid is produced by the electrolytic oxidation of chromium compounds of a lower degree of oxidation, in an acid solution, the kathode and anode of the cell being separated from each other by a wall which does not reach to the bottom of the cell. The electrolyte is supplied in such a manner that the inner or kathode compartment always contains sufficient acid to allow electrolysis to proceed properly, and is introduced, either continuously or intermittently, as a layer near to the bottom of the cell, so that it approaches the anode at the points of greatest current density, and afterwards passes to the points of lower current density. In two examples quoted, 88 and 84–90 per cent. of the chromium was oxidised, 87·5 and 78 per cent. of the current supplied being utilised respectively. W. H. Si.

274. *Preparation of Concentrated Nitric and Sulphuric Acids from Nitro-sulphuric or Nitrous-sulphuric Acid.* (Fr. Pat. 363,157.)—In Der Norske Akt. f. Elektrokemisk. Ind. and M. B. F. Halvorsen's process, nitrosulphuric or nitrous sulphuric acid is dissolved in an excess of concentrated sulphuric acid, and a little water added, together with an oxidiser, *e.g.*, MnO_2, PbO_2, chromic acid, or a chromate. The nitric acid formed is distilled off in iron retorts, and the residue diluted and electrolysed to recover the oxidiser, the reaction when chromic acid is used being—

$$Cr_2(SO_4)_3 + 6H_2O = 2CrO_3 + 3H_2SO_4 + 3H_2.$$

The hydrogen liberated is collected or utilised in obtaining electrolytic copper from copper salts. Ozone or hydrogen peroxide may be used as oxidiser, but cannot be regenerated. W. H. Si.

275. *Manufacture of Magnesium.* (Fr. Pat. 368,761.)—By A. Guntz's process, an excess of dry magnesia or magnesium oxychloride is heated *in vacuo* or in a closed vessel with finely-divided metallic calcium. When oxychloride is used the magnesium collects on the surface of the fused mixture, but with

magnesia the magnesium remains disseminated, in the form of globules, throughout the mass, from which it can be recovered by distillation in a current of hydrogen or *in vacuo*, or by adding magnesium or calcium chloride, with or without calcium fluoride, to the mixture, and fusing the whole, when the magnesium rises to the surface. Barium and strontium may be prepared in a similar manner from baryta and strontia respectively. W. H. Si.

276. *Production of Nitrites.* (Fr. Pat. 868,648.)—The Badische Anilin und Soda Fabrik prepare nitrites by heating the gases formed by passing electric discharges through air, to about 800° C., before bringing them into contact with hydroxides or carbonates of the alkalies or alkaline earths, oxidation not proceeding beyond the state of N_2O_3 at that temperature. Gases containing N_2O_4 can be utilised for the production of nitrites after subjection to a sufficiently high temperature to effect partial decomposition. W. H. Si.

277. *Copper, Nickel, and Cobalt from Ores.* (U.S. Pat. 841,720. Electrochem. Ind., N.Y. 5. pp. 56–57, Feb., 1907. Abstract.)—J. H. Ryan roasts the finely-ground sulphide or arsenide in a McDougall furnace, in which shelves are arranged above one another. On each shelf the ore is roasted for about an hour, at 800° F. on the uppermost, and at 450°, 800°, and 1,000° F. on the lower shelves; the temperature is regulated by letting in hot and cold air and measured by pyrometers. The hot ore is discharged into diluted sulphuric and sulphurous acids prepared from the furnace gases, and the solution electrolysed at a temperature of at least 80° F. The tank is divided so that the electrolyte passes through in a zigzag, and the electrodes are closer together near the inlet than near the outlet; anodes of lead and kathodes of the respective metals are recommended. When the ore to be roasted contains cobalt, it is mixed with 2 or 8 per cent. of sodium chloride. The residue from the bleaching process is neutralised with lime and alkali carbonates, and gold and silver are then extracted with potassium cyanide. H. B.

278. *Treatment of Sulphide Ores.* (U.S. Pat. 840,511. Electrochem. Ind., N.Y. 5. p. 57, Feb., 1907. Abstract.)—R. S. Packard oxidises sulphides of copper and zinc in the pulverised unroasted state by placing the ore in tanks in which strong brine or hydrochloric acid is electrolysed with anodes of carbon; the kathodes are also of carbon or copper or iron sheets enveloped in linen cloth to retain the loosely deposited copper. The liberated chlorine is to decompose the water of the electrolyte. The tank has a false bottom through which the electrodes extend down to the real bottom. If the copper ore contains gold, the electrolysis must be stopped in time lest any deposited gold be redissolved by the ferric sulphate. H. B.

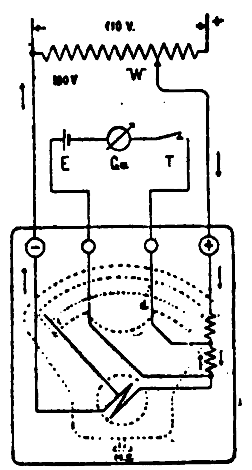
279. *Manufacture of Ferro-alloys in the Electric Furnace.* **P. Girod.** (Soc. Ing. Civ., France, Bull. 59. pp. 720–786, Nov., 1906.)—The methods employed are briefly described, and a list is given of the alloys regularly produced by the Société Anonyme Électrométallurgique procédés P. Girod, viz., ferro-chromes (4), cupro-vanadium, cupro-silicon, ferro-silicons (8), silico-manganese, ferro-tungstens (8), ferro-manganese, ferro-vanadiums (2), ferro-molybdenum, silico-chrome, ferro-titanium. Analyses of each are given. The cost of electrodes per ton of steel made is under 2.50 fr., while for maintenance and repairs another 2.50 fr. may be added, say 5 fr. for

electrodes and maintenance. Per kw.-hour supplied to the furnace 1·25 kg. of steel is obtained, hence per ton (1,000 kg.), 800 kw.-hours are required. [See Abstract No. 1878 (1906).] L. H. W.

280. *Progress in Electro-steel Smelting.* **Eichhoff** and **H. Röchling.** (Stahl u. Eisen, 27. pp. 41–58, Jan. 9; and pp. 81–85; Discussion, pp. 85–88, Jan. 16, 1907. Paper read before the Hauptversamml. des Vereins deutsch. Eisenhüttenleute, Düsseldorf, Dec. 9, 1906. Abstract in Electrochem. Ind., N.Y. 5. pp. 58–59, Feb., 1907. From the Iron Age, Jan. 31, 1907.)—Eichhoff deprecates the exaggerated accounts of the technical press on electric steel furnaces, and speaks briefly and critically on the furnaces of Gin, Kjellin, Schneider-Creusot, and at length on the Héroult-furnace, which he has studied in the works of R. Lindenberg at Remscheid and for which he predicts a future, because it is a metallurgical furnace. The furnaces of Keller, Harmet, and Girod he regards as modifications of Héroult's construction. Electrical features are little touched upon. Emphasising the question of deoxidation, he points out that pipes and blow-holes are produced because some iron oxide is dissolved in the iron and afterwards reduced by the carbon under evolution of CO. From observations on the puddling process, he concludes that the oxide is ferrous (or a still lower) oxide which is only dissolved when the temperature exceeds 1,450° C.; the solubility then increases rapidly. To prevent the formation of this oxide, the slag must be free of iron. The reduction of any ferrous oxide by means of Mn or Si leaves the oxides of these substances in the iron, and the merit of the Héroult process is that no absorption of ferrous oxide from the slag can take place. At Remscheid 1·5 or 2 tons of fairly pure steel are poured from a Martin furnace of the tilting Wellman type into the electric furnace, which can itself be tilted, as it rests on two arc-shaped rails. The iron walls are lined with firebrick, and further with dolomite. Two electric motors on a shunt-circuit keep the two heavy carbon electrodes, which are lowered through the hood of the furnace, at 45 mm. above the steel level; only in one of a thousand charges has trouble been caused by a piece breaking off one of the electrodes. The bath is first covered with an oxidising slag; after heating it for 30 or 45 min. by means of monophase currents of 100 volts, the oxidising slag is withdrawn and carbon strewn on the steel; a new slag of lime and sand, free of iron oxide, is then put on and fused in about 20 min., while some manganese ore is added to the steel. The slag cools the steel so that the ferrous oxide is reduced by the carbon. When the slag has become quite white, a sample of the steel is taken and analysed for carbon, and iron and carbon and further manganese and ferro-silicon are added in accurately calculated proportions. The great purity of the steel and its high mechanical properties, which are shown by tests made by Guillet and at the works, are ascribed to the high temperature of the arc, which does not impair the steel, but which permits of using a very basic slag. The sulphur is eliminated during the last stage, to from 0·007 to 0·0012 per cent.; the final phosphorus percentage ranges from 0·003 to 0·005; C, Mn, Si can be kept within 0·03 or 0·05 per cent. Copper and arsenic are not in themselves deleterious, so long as sulphur is absent. The cost of production of the best steel is below that of crucible steel, the attendance much less exerting, and the product independent of the raw materials. Röchling deals with the Kjellin furnaces, at Gysinge, and two experimental furnaces for charges of 60 and 800 kg. at Völklingen; the latter furnaces can be tilted. Replying to the criticism by Eichhoff that the temperature of the slag in t Kjellin furnace is not high enough for the desulphurisation, he mentions an

experiment made at Gysinge in which a 0·5 percentage of S was, with normal working, reduced to 0·1 per cent.; any addition of fluorspar to the slag is not required. Phosphorus can also be eliminated; the decarbonisation is, however, difficult in the presence of phosphorus, because a phosphate is formed with the basic lining at very high temperatures; the same applies to Mn and Si. The deoxidation succeeds when a slag of lime-dust is used. The induction furnace is put on one phase of a three-phase 50-cycle generator; cos ϕ can be raised to 0·95 in small furnaces, not yet in larger furnaces. The current consumption makes the system commercially successful when liquid Thomas or Martin steel is started with. Analyses of the steels produced at Völklingen are given. In the *discussion*, **H. Goldschmidt** did not see why the Stassano and Kjellin furnaces should, on general lines, be inferior to the Héroult type; they all gave good steel, though we might have a long time yet to wait for the electric iron furnace. **Ellender** mentioned that Girod uses at Ugines only one vertical electrode, the other electrode being formed by six or eight cooled steel segments in the hearth; he questioned Eichhoff's hypothesis of the deoxidation. **Bian** inquired about current fluctuations in Kjellin furnaces, which, according to V. Engelhardt, do not exceed 5 per cent. at Gysinge. At Völklingen, **Röchling** replied, the current curve is straight, except when the charge is renewed or tapped; melting a fresh charge gives a steadily rising curve. H. B.

281. *Self-checking Standard Instruments.* **J. Ramakers.** (Soc. Belge Élect., Bull. 24. pp. 1–15, Jan., 1907.)—The paper describes a series of Weston direct-current moving-coil instruments designed for standard measurements of pressure and current. Each instrument has, in addition to its moving-coil component, a delicate galvanometer, a standard cell, and standard resist-



ances, which enable the indications of the instrument to be checked at any moment by a potentiometer method, after which any error can be corrected by adjusting magnetic shunts. The Fig. shows the diagram of connections for a standard voltmeter, all the parts indicated forming one such instrument. A standard ammeter with shunts and a combined instrument are also described. Weston standard cells are used, as they have no temperature-coefficient. J. D. C.

282. *Electric Heating and Fusing and Firing of Refractory Materials.* **R. S. Hutton.** (Electrician, 58. pp. 577–579, Jan. 25, 1907. Abstract of paper read before the English Ceramic Soc.)—With wire-wound platinum resistance furnaces temperatures of 1,850° can be attained; with tubular carbon furnaces, packed with carborundum or soot, 2,250°. The resistance of the carbon tubes is low, and for some purposes granular carbon may be used as resistance; the Berlin Porcelain Works make small furnaces of this type. The 1,000-h.p. carborund furnaces of Acheson yield 8·15 tons of carborund in a run of 36 hours; the total production of 1904 was 8,152 tons; 2,000-h.p. furnaces are now installed. The Acheson graphite production of 1904 was 1,450 tons, from 1,000-h.p. furnaces. Out of fused alumina Verneuil makes rubies, the Norton Emery Wheel Co. alundum (1,800 tons in 1904); Rheinfelden supplies diamantine, and Goldschmidt another abrasive. The Deutsche Steinzeugwaarenfabrik of Friedrichsfeld supplies superior alumina stoneware. Magnesia crucibles and bricks are brittle, but there is a demand for electrically-shrunk magnesia; the Berlin Porcelain Works supply tubular and other magnesia furnaces. Fused quartz pipes, bricks, and vessels are made by the Thermal Syndicate of Wallsend-on-Tyne. The author gives a good literature list. H. B.

283. *New Form of Induction Instrument.* **P. MacGahan.** (Elect. Journ. 4. pp. 113–117, Feb., 1907.)—The author gives an account of the new induction ammeters and voltmeters introduced by the Westinghouse Co., and designed by F. Conrad. The core of the instrument consists of stampings closely resembling those of an ordinary bipolar dynamo field magnet, and between the pole-pieces is a fixed laminated cylindrical core. In the annular gap between the pole-pieces and this core is pivoted a light hollow aluminium drum, which is provided with the usual control spring and pointer. Around the magnet cores are arranged two windings, a primary and a secondary. The pole-pieces are provided with deep slots at the extremities of a diameter along the magnetic axis, and the slot in each pole-piece contains a winding embracing the pole-piece and supplied with current from the secondary surrounding the magnet core. The winding around the pole-pieces produces a magnetic flux, which is nearly in time and space quadrature with the main flux due to the resultant of the primary and secondary ampere-turns, a rotating field being thereby produced in the gap which deflects the aluminium drum. In an ammeter, the primary winding carries the current to be measured; in a voltmeter, this winding is connected in series with a large non-inductive resistance. The advantages claimed for the instruments are automatic compensation for frequency and temperature, without the use of special compensating devices. Since the secondary ampere-turns are always nearly equal to the primary ones, a change of frequency when the primary current is constant will only change the induction in the inverse ratio of the frequency, but will leave the secondary current unaltered. Again, a rise in temperature, while increasing the rotor resistance, also causes an increase in the resistance of the secondary winding, and as a result an increase of the main flux, which compensates for the increased rotor resistance. A. H.

284. *Improvement of Scale of Induction Instruments for Alternating Currents.* (Engineering, 83. p. 225, Feb. 15, 1907.)—In Brit. Pat. 774 of 1906, S. Z. De Ferranti, M. B. Field, C. C. Garrard, and Ferranti, Ltd., describe means whereby the scale of a measuring instrument of the induction type, which is, as a rule, unsatisfactory, may be rendered uniform or modified in any manner

desired, by making the rotor of variable thickness. Such a rotor may be made by rotating a copper disc, originally of uniform thickness, with part of its lower half in an electrolytic bath, but so shielded that the deposit only takes place over a segment or part of a circle, and varying the depositing current during the rotation, so as to produce any desired variation of thickness. If a uniform scale is desired, the rotor disc is so arranged that as the deflection increases the thickness of that part of the disc which is under cover of the shaded pole of the deflecting magnet decreases. A. H.

285. *Testing of Electric Machinery and Materials of Construction.* **J. Epstein.** (Inst. Elect. Engin., Journ. 38. pp. 28–68; Discussion, pp. 68–108, Feb., 1907. Electrician, 58. pp. 251–253, Nov. 30, and pp. 324–327; Discussion, p. 327, Dec. 14, 1906. Abstract. Elect. Engin. 38. pp. 769–773, Nov. 30; 806–808, Dec. 7, and pp. 848–851, Dec. 14, 1906.)—The author deals with the testing of copper, iron, and steel, insulating materials, carbon brushes, the determination of the temperature-rise in transformer and field coils and armatures, the determination of the iron, copper, and frictional losses in finished machines, the regulation of alternators and transformer, the overload capacity and torque of motors. Attention is drawn to the great discrepancy which is frequently found to exist between the actual iron loss in a finished machine and the loss calculated from laboratory tests on small samples of the material. In connection with the testing of insulating materials, the importance of the size of the testing electrodes is pointed out, the break-down voltage being always less with larger testing electrodes; the author uses electrodes 25 × 25 cm., with rounded corners and edges. A. H.

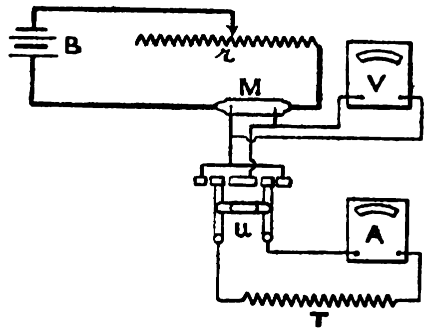
286. *Measurement of Phase-differences.* **A. J. Makower.** (Electrician, 58. p. 695, Feb. 15, 1907.)—The following method has been used by the author for determining the phase displacement between the currents in a current transformer. Two alternators are coupled in such a way that their e.m.f.'s can be adjusted to any required phase-difference. Two wattmeters are required. Their volt-coils are connected in parallel between the terminals of the first machine. The ampere-coil of the first wattmeter is put in series with the primary coil of the current transformer and a resistance, the circuit being connected across the terminals of the second machine. The secondary coil of the current transformer is now connected across the ampere-coil of the second wattmeter. Under these circumstances, if ϕ be the known phase-difference between the alternator e.m.f.'s, δ the phase-difference of the two currents in the transformer, and W_1 and W_2 the wattmeter readings, we have, on the usual assumptions, $W_1/W_2 = \lambda\,[\cos(\delta + \phi)]/\cos\phi$, where λ is the transformation ratio of the current transformer. Hence—

$$\delta = \cos^{-1}(W_1 \cos\phi/W_2\lambda) - \phi.$$

A curve was plotted of the values of W_1/W_2 for various values of ϕ, and several values of δ were found. For a current transformer having the transformation ratio of unity ($\lambda = 1$) the mean value of a series of determinations of δ was 0·9 of a degree. [See also Abstract No. 166 (1907).] A. R.

287. *Measurement of Hysteresis Loss.* **G. Kapp.** (Elect. Engin. 39. p. 224, Feb. 15, 1907. Ind. Élect. 16. pp. 83–84, Feb. 25, 1907.)—The arrangement of connections used in the method devised by the author is shown in the sketch. T is the fine-wire winding (or both windings in series) of the trans-

former, connected in series with the ammeter A and, through the reversing switch u, across the resistance M. Through this resistance a constant current is maintained by the battery B, r being a rheostat. The battery current is adjusted to be about 50 times the magnetising current of the transformer. The ammeter A must be a central zero instrument. With the switch u in a given position, and the desired magnetising current flowing through the transformer, the switch is suddenly thrown over, and at the same time a



stop-watch is started. The times taken by the current to reach definite values are noted, and from these the time-current curve is plotted. The difference of the curve areas corresponding to positive and negative values of the current during a reversal gives the coulombs supplied during the current change. If these be multiplied by the practically constant voltage across M (as measured by the voltmeter V), we obtain the energy, in watt-seconds, absorbed by the transformer. On subtracting from this the heat loss in the transformer coil, we find the hysteresis loss during a half-cycle.

A. H.

288. *Brake Systems for electrically operated Lifting and Winding Gear.* **F. Jordan.** (Zeitschr. Vereines Deutsch. Ing. 50. pp. 2011–2017, Dec. 15; 2056–2061, Dec. 22, and pp. 2097–2108, Dec. 29, 1906.)—Brakes for the above purposes are divided by the writer into the following six classes: (1) Braking merely due to the friction of the transmission system. (2) Hand brakes (including hand-applied brake shoes or belts, differential brakes, and ratchet brakes). (3) Magnetic brakes. (4) Load-pressure brakes. (5) Electric brakes. (6) Compressed-air brakes. The requirements which should be fulfilled by brakes for electrically driven lifting and winding gear may be stated to be as follows: (1) The brake must under all circumstances be absolutely reliable in service. (2) The brake, when once applied, must not be capable of automatically releasing itself. (3) The brake must not permit of a dangerous speed. (4) The brake must act smoothly and with freedom from all shocks. (5) The brake must be capable of bringing the load to a standstill within a very short distance, and must do this when running in either direction. Its operation in this respect must be as uniform as possible, and independent of its speed. (6) The brake must be capable of being closely controlled to operate within fine limits. (7) The brake must be capable of being rapidly and readily applied and released. (8) The brake must be as cheap as possible with respect to initial outlay and cost of operation and maintenance. (9) The brake must be simple in construction, and its method of operation must be easily comprehensible to all workmen. The writer applies these

criteria to the six varieties of brakes, and concludes that the compressed-air brake is by far the most suitable for the purpose in question. He describes the compressed-air brake developed by the firm of H. H. Böker and Co., of Lankwitz, for use in connection with lifting and winding work. The description is accompanied by a number of sketches of the chief parts, diagrams of the controller, and curves showing the results obtained in operation.

H. M. H.

289. *Electric Shovels for Railway and Mining Excavation.* (Eng. News, 57. p. 68, Jan. 17, 1907.)—The use of electric shovels in place of steam shovels offers several advantages where electric current is available and a number of such shovels are in use, being employed in placer-mining and in gravel-pit and grading work on electric interurban railways. The chief advantages are: (1) the machine requires only two men, while three are usually employed on the steam shovel; (2) the hauling of coal and water is avoided; (3) the fuel economy is higher. An illustration is given of a 40-ton electric shovel, having a 65-h.p. motor for hoisting, one of 25 h.p. for crowding the dipper forward and bringing it back, and a third of 20 h.p. for swinging the crane. Direct-current at 500 volts is used. W. J. C.

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290. *Electro-positive Protection for Iron and Steel.* S. Cowper-Coles. (Elect. Engin. 38. pp. 296–301, Aug. 31, 1906. Paper read before the British Assoc. at York. Electrician, 58. pp. 52–55, Oct. 26, and pp. 89–91, Nov. 2, 1906. Engineering, 82. pp. 247–248, with Discussion, Aug. 24, 1906.)—Deals with the "sherardising" process [Abstract No. 2171 (1904)].

291. *Electrolyte for the Production of Alkali Metals.* (U.S. Pat. 841,724. Electrochem. Ind., N.Y. 5. p. 56, Feb., 1907. Abstract.)—In order to lower the melting-point of the alkali chloride, G. O. Seward and F. v. Kügelgen mix four parts of NaCl with two of NaF and one of $BaCl_2$; in the case of potassium KCl, KF, and $BaCl_2$ are used. The earth-alkali salt is not decomposed at the suitable current density. H. B.

292. *Lead and Zinc from Sulphide Ores.* (U.S. Pat. 841,102. Electrochem. Ind., N.Y. 5. p. 56, Feb., 1907. Abstract.)—C. E. Baker and A. W. Burwell pulverise the dry sulphidic ore, and bring it in a revolving drum in contact with vapours of S_2Cl_2. The sulphur is recovered, and the fused metal chloride electrolysed with graphite anodes and kathodes of molten lead or zinc; the chlorine is used for producing sulphur chloride. H. B.

293. *Copper from Sulphide Ores.* (U.S. Pat. 841,103. Electrochem. Ind., N.Y. 5. p. 56, Feb., 1907. Abstract.)—C. E. Baker and A. W. Burwell treat copper sulphide like the other sulphidic ores with S_2Cl_2 and leach the cuprous chloride out and electrolyse it. H. B.

GENERATORS, MOTORS, AND TRANSFORMERS.

294. *Method of determining the Efficiency of Direct-current Dynamos.* **P. Soulairol.** (Écl. Électr. 50. pp. 185–191, Feb. 9, 1907.)—In this method we run the machine first as a dynamo and then as a motor, the speed, the excitation, and the current in the armature being made the same in the two cases. From our readings we obtain the efficiency at all loads of the machine as a generator and a motor. The case of a machine with separate excitation is first considered. Under the given conditions when the machine is acting as a generator, we have (1) $EC = V_gC + RC^2$, where E is the e.m.f., C the current, V_g the p.d. at the terminals, and R the resistance of the armature. If P_g be the power given to the pulley and p be the sum of the mechanical, hysteresis, and eddy-current losses, we have (2) $P_g = V_gC + RC^2 + p$. The corresponding equations for the motor are (3) $V_mC = P_m + p + RC^2$, and (4) $EC = P_m + p$ since E is the counter-e.m.f. of the motor. From (4), (1), and (2) we get $P_m + p = V_gC + RC^2 = P_g - p$, and therefore, (5) $P_g - P_m = 2p$. By adding equations (3) and (2) and using (5) we get $(V_m - V_g)C/2 = RC^2$...(6), also from (3) and (2) $P_g + P_m = (V_m + V_g)C$...(7). The efficiency η_g of the generator is given by $\eta_g = V_gC/(V_gC + RC^2 + p) = V_gC/[(V_m + V_g)C/2 + p]$...(8), and the efficiency η_m of the motor by—

$$\eta_m = (V_mC - RC^2 - p)/(V_mC) = [(V_m + V_g)C/2 - p]/(V_mC)...(9).$$

If we know p, therefore, and the characteristics of the machine as a generator and a motor running at the same speed and excitation and with the same current in the armature, we can tell the efficiency of the machine by formulæ (8) and (9). If in formulæ (5), (7), and (8) we suppose that P_m is zero and that P_g, V_g, V_m, C and R are respectively P'_g, V'_g, V'_m, C′ and R′ we have $p = (V'_m + V'_g)C/2 = V'_mC' - R'C'^2$. Thus p can be found. In the above formulæ RC^2 may be supposed to include the total loss due to the Joule effect, and thus R will always be greater than the resistance of the armature and will vary with the load. The case of a shunt-wound machine is next considered; the formulæ are shown to be practically as simple as those given above. A description is given of the five characteristics that have to be found in order to completely determine the working of the machine. A. R.

295. *Commutation.* **F. G. Baily and W. S. H. Cleghorne.** (Inst. Elect. Engin., Journ. 38. pp. 150–182; Discussion, pp. 182–189, Feb., 1907. Paper read before the Glasgow Local Section. Electrician, 58. pp. 202–205, Nov. 23, and pp. 365–367, Dec. 21, 1906. Abstract. Elect. Engin. 38. pp. 779–782, Nov. 30; 813–816, Dec. 7, and pp. 919–920, Dec. 28, 1906.)—The authors describe the results of numerous elaborate experiments on brush contact resistance, friction of carbon brushes, effect of lubrication on contact resistance and friction, effect of vibration, resistance of brush contact with commutator at rest, effect of time on contact resistance, the sparking e.m.f. between the trailing brush edge and the receding segment, the flux distribution and the effect of the short-circuit currents in the case of a motor with commutating poles, and the variation of the current in the segment under the brush. The results of the experiments on brush contact resistance confirm generally the work

of Arnold [Abstract No. 1056 (1906)] and others. With a stationary slip-ring, the contact p.d. was found to increase practically in proportion to the increase of current, thus following a different law from that which holds good in the case of a rotating slip-ring. The use of paraffin wax as a lubricant was found advantageous, decreasing friction while not affecting voltage drop. It is desirable to use a high-current density at the brush contact, as this reduces the frictional loss while not affecting the electrical loss. The main practical conclusions deduced by the authors from their experiments are that while a low self-inductance is necessary in the coils, a uniformly high brush contact resistance is not advantageous, for while it hastens the fall of current in the receding segment, it also retards the rise of current in the advancing one; and that a wide interpolar space, a short air-gap, good brush-holders and narrow brushes, are important factors in bringing about sparkless commutation. A reversing e.m.f. is desirable, but not necessary. A. H.

296. *Reversing-Pole Machines with Salient and Consequent Poles.* **F. Pelikan.** (Elektrotechnik u. Maschinenbau, 25. pp. 153–155, Feb. 24, 1907.)—The author briefly discusses the relative merits of the above two forms of construction. When salient poles are used, short gaps for the reversing poles become impossible, owing to the danger of a strong magnetic side pull. With consequent poles, arranged like those of an induction motor, this danger does not exist to any large extent. The two designs are worked out in detail for a 4·5-kw. machine, and it appears that in this special case the consequent-pole design involves the use of about 37 per cent. more copper. A. H.

297. *Improved Form of Compensating Winding.* (Mech. Eng. 19. p. 297, March 2, 1907.)—A recent invention of C. A. Parsons and J. H. Armstrong relates to an improved method of construction for the compensating winding. The winding is of copper strip, but instead of being wound by hand in holes punched out in the pole-shoes, it is secured in position, *after* having been formed, by means of laminated teeth provided with expansions, the teeth being clamped or bolted in any suitable manner to the field poles. A. H.

298. *New Heyland Self-regulating Alternators.* **A. Heyland.** (Electrician, 58. pp. 632–635, Feb. 8, and pp. 671–675, Feb. 15, 1907. Elektrotechn. Zeitschr. 28. pp. 121–126, Feb. 7, and pp. 142–145, Feb. 14, 1907.)—The general principle of this type of alternator has already been explained [Abstract No. 1806 (1906)]. In the present article, the author considers in detail some of the questions which arise in connection with the method of regulation employed by him. An alternator of the new type is completely self-regulating, and, if desired, may be over-compounded. The auxiliary "unipolar" flux serves a double purpose: it corrects the alternator voltage with regard to fluctuations in the load, and also counteracts voltage fluctuations due to changes of speed or other external disturbances. The new method may be applied to any ordinary alternator, and the necessary modifications may be calculated with considerable accuracy. These calculations are fully worked out by the author for a 850-kw. machine, the auxiliary flux being arranged to have a maximum value at no load, and zero value at full load, so that the exciter voltage steadily rises until full load is reached. The method has the advantage of utilising the active material

on the machine to the fullest possible extent. Although the author gives very exact calculations for the machine considered, great accuracy is not required in such calculations, as the final adjustment can always be readily carried out on the finished machine, by the simple expedient of placing a variable shunt across the field coils of the weaker or stronger poles, and adjusting this until the desired result is obtained. A. H.

299. *Leakage Factor of Induction Motors.* **A. S. McAllister.** (Electrical World, 49. pp. 181–182, Jan. 26, 1907. Écl. Électr. 50. pp. 315–317, March 2, 1907.)—According to Behrend, the leakage factor σ is given by $\sigma = C\delta/t$, where $\delta =$ radial depth of air-gap, $t =$ pole-pitch, and C is a coefficient termed the "dispersion factor." Hobart's investigations [Abstract No. 1884 (1904)] show that C may conveniently be regarded as made up of two factors, c and c', so that $C = cc'$, the factor c depending on the ratio of t to the core-length l and on the percentage opening of the slots, and the factor c' on δ and the average number h of stator and rotor slots per pole per phase. The factor c may be termed the "main dispersion" factor, and the factor c' the "zigzag dispersion" factor. On examining the values of c and c' given by Hobart, the author finds that they may be represented by comparatively simple equations, and that the numerical constants are as given by the following equation :—

$$C = cc' = \left(10{\cdot}5 - 5{\cdot}5S_0 + \frac{2{\cdot}9t}{l}\right)\left(0{\cdot}54 + \frac{0{\cdot}247}{\delta h}\right),$$

where S_0 is the ratio of the width of slit at the top of a slot to the width of slot. A. H.

300. *Leakage Factor of Induction Motors.* **A. Baker** and **J. T. Irwin.** (Inst. Elect. Engin., Journ. 38. pp. 190–208, Feb., 1907.)—The experiments described by the authors were undertaken with the object of arriving at a more accurate expression for the dispersion factor than that given by Behn-Eschenburg [Abstract No. 1882 (1904)]. The experimental apparatus consisted of stampings so arranged that the length of gap could be easily varied by means of distance-pieces. The formula for the dispersion factor σ established by the authors is—

$$\sigma = \frac{4}{N^2} + \frac{\delta}{X.N.T.} + \frac{6\delta}{b} + \frac{7{\cdot}2\delta . D_s}{T.N.W_s},$$

where $N =$ mean number of stator and rotor slots per pole-pitch ; $\delta =$ length of air-gap ; $X =$ slit width at top of slot ; $T =$ pole-pitch ; $b =$ core-length ; $D_s =$ depth of slot ; $W_s =$ width of slot. By applying this formula to the 88 motors investigated by Behn-Eschenburg, the authors obtain results which agree to within 12·8 per cent. with the observed values, whereas the agreement of Behn-Eschenburg's original formula was 28·4 per cent. The mean divergence from the observed results is only 4 per cent., the values given by the formula being too low. A. H.

301. *Theory of Single-phase Induction Motor.* **A. Thomälen.** (Elektrotechn. Zeitschr. 28. pp. 190–194, Feb. 28, 1907.)—In continuation of his previous work on this subject [Abstract No. 86 (1906)], the author uses the circle diagram to establish expressions for the slip and torque. The investigation is then extended to the case in which the stator losses are

not negligible. It is shown that in this case also the extremity of the primary current vector moves along a circle, and expressions are obtained for the slip, torque, efficiency and power-factor. A. H.

302. *Alternating-current Commutator Motors with Shunt Characteristic.* (Electrical World, 49. p. 298, Feb. 9, 1907.)—A brief account of patents recently granted to B. G. Lamme and C. Renshaw for arrangements based on the following principle. Taking the case of a single-phase commutator motor provided as usual with a compensating coil, it is found that the p.d. across the field winding is nearly in quadrature with the current, while the p.d. across the armature and its compensating coil is nearly in phase with the current. From this it follows that if the field and armature circuits be disconnected and supplied separately from two sets of mains whose p.d.'s are in quadrature, the field and armature currents will be nearly in phase. The inventors propose using commutator motors on polyphase circuits in this way. (U.S. Pats. 839,985, 6, 7, 8, 9, and 840,001). A. H.

303. *Prevention of Sparking in Single-phase Commutator Motors.* (Electrical World, 49. pp. 346–347, Feb. 16, 1907.)—Arnold and La Cour propose, in a recent patent (U.S. Pat. 842,163), the use of resistances between commutator segments forming groups connected to different sections of a multiple wave-winding. If, for instance, the winding is a triple one, then assuming that the first, second, and third windings are in connection with segments 1, 2, and 3 respectively, there would be preventive resistances between segments 1 and 2, 2 and 3; 4 and 5, 5 and 6; and so on; but no resistances between 3 and 4, 6 and 7, &c. A. H.

304. *Three-phase Transformation.* **A. S. McAllister.** (Electrical World, 49. pp. 302–304, Feb. 9, 1907.)—The author compares the relative advantages of the various methods available for effecting three-phase transformation. The three-phase transformer is cheaper and more efficient than three single-phase transformers having the same total rating, and is to be preferred to any other possible equipment. So far as concerns the cost of the equipment and efficiency of operation, two T-connected transformers are preferable to either two V-connected or to three Δ- or Y-connected transformers. The Δ-connection is, however, the only one capable of dealing with a three-phase load when one of the transformers happens to break down. As regards the maintenance of balance of the three phases, the T-connection is much better than the V-connection, and in many cases it is also to be preferred to either the Δ- or Y-connection of three separate transformers. A. H.

REFERENCES.

305. *Calculation of Interpoles.* **A. G. Ellis.** (Electrical Times, 31. pp. 42–44, Jan. 10, 1907.)—A detailed explanation of the method of calculating reversing poles developed and employed by Hobart. A. H.

306. *Commutation.* **C. L. Kennedy.** (Electrical World, 49. pp. 344–346, Feb. 16, 1907.)—The author gives an outline of the theory of commutation, and deduces expressions for the self-inductance of an armature coil, and for the maximum armature current at which sparkless commutation is still possible when the brushes are set at the geometrical neutral point. A. H.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

307. *Use of Steel Rails for Electric Railway Feeders.* **J. Alsberg.** (Eng. News, 57. p. 40, Jan. 10, 1907.)—Several methods are described for employing steel rails instead of copper cables as feeders for electric railways. In the preferable method an L-shaped cross-section of rail is employed. This is placed in a triangular-shaped trough, the apex being placed at the bottom and the base at the top. The end of one rail is lapped 8 in. inside the adjacent rail, and the plastic bond is bolted between the metal surfaces where the rails overlap ; two bolts are sufficient to hold the ends together. The sections of the wooden trough are lapped in the same manner as the rails. It is desirable to line the trough with tarred paper to prevent the escape through the joints of any of the insulating compound. Large blocks of glass are introduced between the wooden trough and the rails, and the trough is filled in with a hot petroleum residue compound. The trough is finally closed with a board cover. Taking steel rails with a conductivity equal to 1/7½ times that of copper, the equivalent of 0·79 sq. in. (1,000,000 circ. mils.) of copper cable calls for a rail with a cross-section of 5·9 sq. in. and a weight of about 68 lbs. per yard. Using 80-ft. rails and lapping 8 in. at the joints, the writer estimates the total cost per mile to be about £770. The itemised costs are given in the following table :—

Cost per Mile of Feeder, using New Rails and Equivalent to 0·79 sq. in. of Copper.

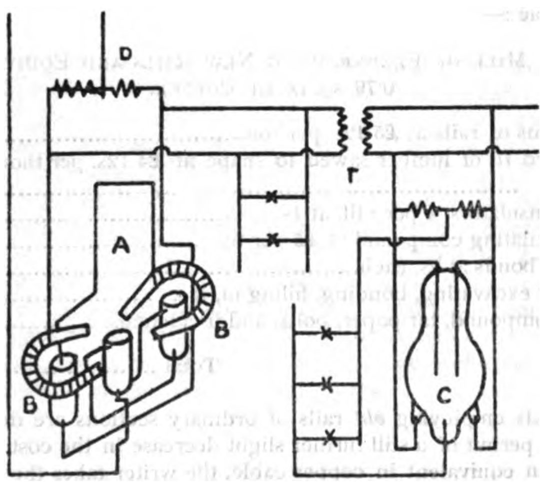
	£
58 gross tons of rails at £5 12s. per ton	297
18,000 board ft. of lumber sawed to shape at £4 12s. per thousand board ft.	83
720 glass insulators, 4 per rail, at 1s.	36
40 tons insulating compound at £5 per ton	200
180 plastic bonds at 2s. each	18
Labour for excavating, bonding, filling in, &c.	120
Heating compound, tar paper, bolts, and incidentals	20
Total	£774

Other methods employing *old* rails of ordinary sections are described, and are shown to permit of a still further slight decrease in the cost. Coming to the case of an equivalent in copper cable, the writer takes the cost per mile for a triple-braided weatherproof grade with this same cross-section of 0·79 sq. in. (1,000,000 circ. mils) as £960. Adding the cost of insulators, stringing of cable, extra brackets, pins, &c., a total outlay per mile for overhead copper feeder of some £1,040 is arrived. A lead-covered insulated cable, to be used with underground conduit construction, would cost very much more. The writer states that a much greater saving is effected by this use of steel feeders when employed in conjunction with an elevated railway structure. Here the only expense, in addition to the cost of rails, is stated to consist of paraffin-wood insulators or their equivalent, used every 10 ft., and a

separately supported plank covering above them. The feeders are located between the two tracks, and a board covering over them furnishes a walk for the use of inspectors and workmen. H. M. H.

308. *Calculation of Voltage Drop in Alternating-current Conductors and Networks.* L. Lichtenstein. (Elektrotechn. Zeitschr. 28. pp. 115–121, Feb. 7, 1907. Écl. Electr. 50. pp. 356–360, March 9, and pp. 392–394, March 6, 1907 *et seq.*)—In dealing with problems relating to alternating-current distribution, it is customary to employ one or other of two methods. In the first method each conductor is considered by itself, and regarded as contributing a certain amount towards the total magnetic flux; while in the second method closed loops formed by the conductors are always considered. The author regards this latter method as preferable to the former, and as having a clearer physical significance; for this reason he employs it exclusively in his investigations. Some general equations are first established which are then applied to a number of problems, illustrated by numerical examples taken mainly from railway practice. The results obtained are of interest in connection with single-phase railways. A. H.

309. *Changing Continuous-current Voltage by Means of Mercury Vapour Converter and Static Transformer.* (West. Electn. 40. p. 146, Feb. 16, 1907.)—The following arrangement for raising or lowering the voltage of a continuous-current circuit by means of a triple transformation not involving the use of any rotating machinery, has been patented by E. Weintraub, and



is illustrated in the Fig. The mercury vapour apparatus shown diagrammatically at A has three tubes containing mercury. The central tube is connected to the negative main, and the two outer tubes to the positive main through the choking coil D. The two electromagnets B are intended to aid the alternate movement of the mercury vapour arc from the one anode to the other. [Compare Vreeland, Abstract No. 226 (1907.) By means of the transformer T, the voltage is changed in any desired ratio, and is then rectified by the rectifier C of ordinary construction. A. H.

310. *Potential-rises due to Resonance.* **H. Zipp.** (Elekt. Runds. 24. pp. 67–69, Feb. 18; and pp. 89–92, Feb. 27, 1907.)—After a brief account of electrical resonance in general, the author studies in detail the case of an alternator connected through mains of definite capacity to a transformer or transformers at a distance. The capacity of the mains may be regarded as connected in parallel with the inductance of the transformer, and the branched circuit so formed may be replaced by a certain equivalent resistance, inductance and capacity all connected in series with each other and with the resistance and inductance of the alternator armature. In the equivalent series circuit so formed resonance phenomena may occur if the frequency is suitable. Oscillations of a frequency greatly in excess of the normal frequency of operation may be started by sparking either at the switches or at the lightning arresters, or by the blowing of a fuse. When a spark passes in such cases it lowers the resistance between the sparking electrodes to practically zero, and the voltage between them for the moment drops to a zero value. Immediately afterwards an interruption takes place, with a very sudden rise of voltage to the normal instantaneous value; a second spark passes, followed by another interruption and voltage rise; and so on. The normal e.m.f. wave is thus cut up into numerous strong ripples whose crests lie along the normal wave, while their troughs reach down to the axis of time. If the frequency of the ripples happens to be the critical one corresponding to resonance a breakdown may take place. A. H.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

311. *Plant of the Halifax (Nova Scotia) Tramway Company.* **P. A. Freeman.** (Canad. Elect. News, 16. pp. 271–276, Oct., 1906. Paper read before the Mining Soc. of Nova Scotia.)—At the tramway station there are seven 250-h.p. Babcock and Wilcox boilers. Four of these have connected to each a B. and W. superheater containing about 330 sq. ft. The pressure averages about 150 lbs. There are also installed fourteen Jones underfeed stokers. In one year's actual operation with stokers against hand-firing, there was an actual saving shown under same operating conditions of 11 per cent., and since the automatic feed attachment was put in a further saving of 10 per cent. was obtained. The engine-room contains three Rice and Sargent horizontal cross-compound condensing engines, of rated capacity 900 i.h.p. at 150 r.p.m. *Generators.*—On each engine shaft one 600-kw. C.G.E. alternating generator, 2,200 volts, 60 ∿. As regards steam jacketing, the author does not advise the jacket on the cylinder barrel on account of liability to fracture through unequal heating. He, however, strongly advises its use on the cylinder heads. W. J. C.

312. *Snowdon Hydro-electric Plant of the North Wales Power Co.* (Elect. Rev. 59. pp. 911–919, Dec. 7, and pp. 955–959, Dec. 14, 1906. Elect. Engin. 38. pp. 870–876, Dec. 21, and pp. 908–912, Dec. 28, 1906.)—This scheme uses a 1,100-ft. water drop from lakes Glas-Lyn and Llyn Llydaw into the valley below, and includes a series of high-tension transmissions, which pass over the mountains and supply energy to the very extensive slate quarries of North Wales. The power-house contains at present four 1,500-h.p. twin Pelton wheels coupled direct to 3-phase Bruce-Peebles alternators. The water pressure is practically 500 lbs. per sq. in. at the nozzles. The alternators are of the revolving field type, with 12 poles and a rated output of

1,500 kv.a. at a pressure of 10,000 volts, and 50 cycles. Various pole-line constructions have been adopted in the carrying out of the work according to circumstances; for the most part creosoted wooden poles are used, 7 to 9 in. diam., sunk 6 ft. into concrete at the base, and spaced on the average at 40 to the mile. There is telephonic communication along the whole length of transmission lines. In the slate quarries the electrical energy is used to drive motors, pumps, &c., of a very large size and diversified character.

W. J. C.

813. *Tests of Three-phase Plant for Seville Power-transmission Scheme.* **L. Legros.** (Schweiz. Elektrot. Zeit. 3. pp. 539–541, Nov. 3; 551–553, Nov. 10; 564–566, Nov. 17; and pp. 578–580, Nov. 24, 1906.)—For supplying power to the city of Seville, a hydro-electric generating station, situated at El Corchado, 128 km. from Seville, has been built. The initial power absorbed by the turbines is to be 4,500 h.p., and the initial capacity of the generators 3,900 kv.a. Transmission is to take place by means of 3-phase currents at 50,000 volts and a frequency of 40. The plant tested, which is being supplied by the Oerlikon Co., included the following: (1) 3 3-phase, 1,300-kv.a., 5,000-volt, 400-r.p.m. generators; (2) 2 shunt-wound, 65-kw., 110-volt, 1,000-r.p.m. exciters; (3) 7 step-up, 5,000- to 30,000-volt, 600-kv.a., single-phase transformers; (4) 7 step-down, 27,000- to 3,500-volt, 600-kv.a., single-phase transformers; (5) 4 step-down, 27,600- to 3,400-, 3,500- and 3,600-volt, 200-kv.a., single-phase transformers; (6) 1 three-phase, step-down transformer, of 360 kv.a., and 27,300 to 3,400, 3,500, and 3,600 volts; (5) and (6) are intended for a substation at Utrera. The pole-shoes of the generators are provided with skewed and bevelled edges for the purpose of eliminating the higher harmonics from the e.m.f. wave. The resistance of the field winding (hot) is 0·719 ohm. The open-circuit and short-circuit characteristics of two of the alternators were determined, as well as the load characteristic (connecting p.d. with exciting current) for $\cos\phi = 0$. The latter was obtained by over-exciting one of the machines and under-exciting the other until the full-load current of 150 amps. was obtained at various terminal p.d.'s. The regulation at various power-factors is contained in the following table:—

Power-factor	1	0·9	0·85	0·8	0
Percentage voltage-rise on switching off full-load current	5·6	13·5	14·3	15·2	19·2

The no-load losses were then determined by running one of the machines as a motor (the excitations being adjusted so as to obtain minimum current), and were found to amount to 35 kw. The resistance of the armature per phase (hot) was 0·162 ohm. The full-load loss (exclusive of excitation) was thus calculated to be 46 kw., on the assumption that there were no additional losses at full load. In order to determine the amount of these additional losses, the power absorbed by one of the machines when running as a motor was directly measured, the excitations being so adjusted as to produce the full-load current (150 amps.) between the machines at the normal p.d. The measured loss was 53 kw., or 7 kw. (about 15 per cent.) in excess of the calculated amount. Including excitation losses, the efficiencies at full load were 95·9 and 94·9, and at half-load, 93·1 and 91·6, at $\cos\phi = 1$ and $\cos\phi = 0·85$ respectively. After 5 hours' running at full load ($\cos\phi = 0$), the temperature-rises were found to be as follows: Armature core, 30° C.; armature winding,

15° C.; field winding, 21° C. The full-load losses in the exciters were found to be 6·2 kw. for each machine (two methods being used—the no-load run of one of the machines as a motor, and the Hopkinson test). The transformer tests gave the following results:—

Transformers	(3)	(4)	(5)	(6)
Core loss, kw.	8·2	7·8	8·22	6·65
No-load current, low-voltage side	4·95	7	5·5	8·8
Copper loss (from short-circuit test), kw.	6·06	6·25	1·92	4·28
Voltage required to produce full-load current on short-circuit (low-voltage side)	1,548	1,357	1,047	1,290
Full-load efficiency $\cos\phi = 1$	97·7	97·8	97·5	97
Full-load efficiency $\cos\phi = 0·85$	97·3	97·4	97	96·6
Half-load efficiency $\cos\phi = 1$	96·9	97	96·4	95·9
Half-load efficiency $\cos\phi = 0·85$	96·4	96·5	95·9	95·2

A. H.

314. *Toledo and Chicago Interurban Single-phase Railway.* J. R. Hewett. (Street Rly. Journ. 28. pp. 556–564, Oct. 13, 1906.)—The system is single-phase current at 3,300 volts on sections of the road near the power-house, and 33,000 volts with substations for sections further away. The car motors are of 75 h.p. each, and capable of operating on both direct and alternating current. Curtis turbines are installed in the power-house, and steam is generated by Stirling boilers. The trolley wire is of the suspended catenary type, and is insulated to withstand a test pressure of 40,000 volts. The poles are spaced 150 ft. instead of the usual 100 ft. All guy and anchor wires are insulated by means of special wooden strain insulators, the body being of selected hickory subjected to a special compound which impregnates every portion of the wood, effecting an excretion of moisture and increasing the strength and toughness of the wood. Changing from alternating- to direct-current operation or *vice versâ* is accomplished by means of a dead section in the trolley wire which is made as long as possible without exceeding the span on the two trolley poles. Instantly on entering the dead section, whichever main switch is closed will open owing to its energising circuit being broken. The car runs over the dead section at high speed. W. J. C.

315. *Vienna-Baden Single-phase Railway.* (Elektrotechn. Zeitschr. 27. pp. 1151–1157, Dec. 13, 1906. Elekt. Kraftbetr. u. Bahnen, 5. pp. 9–12, Jan. 4, and pp. 25–28, Jan. 14, 1907.)—The electrical equipment of the rolling stock to be used on this line has been carried out by the Austrian Siemens-Schuckert works. There are 14 motor and 18 trailer cars. The arrangements had to be such as to enable the cars to run over the 500-volt, continuous-current systems of the Vienna street railways at one end and the Baden-Vöslau railway at the other. Each motor car is supported by a couple of trucks placed 6 m. apart. The truck wheel-base is 1·85 m., and each axle is driven by a 40-h.p., 250-volt, 6-pole, series, single-phase (or continuous-current) commutator motor. In addition to the exciting and compensating windings, the stator is provided with a reversing-pole winding. There are no high-resistance connectors between the armature winding and the commutator. The carbon brushes are 10 mm. thick. The two motors on the same truck are permanently connected in series, and the two series groups so formed are controlled by a series-parallel controller provided with a

solenoid blow-out. In order to secure a more efficient method of speed control along the single-phase part of the track, an auto-transformer is provided, by means of which the supply voltage may be raised or lowered by 125 volts in a succession of steps. The "transformer controller," by means of which the voltage may be varied, is of similar construction to the series-parallel controller; a safety resistance similar to that used in accumulator switches prevents short-circuiting of the turns included between two neighbouring contacts. Each motor car is, in addition to the hand and motor brakes, fitted with a Hardy vacuum brake. The air-pump is driven by a 2-h.p., 500-volt, 900-r.p.m., commutator motor, whose armature is provided with a double winding and two commutators, so that each commutator is supplied at a voltage not exceeding 250. A pantagraph double-bow trolley is used for collecting the current from the overhead line, whose height above rail-level varies from its normal of 5·5 to 6 m., to 3·9 m. where the line passes under bridges. A train consisting of one motor and two trailer cars and having a gross weight of 62 tons is capable of running continuously at a speed of 40 km. per hour up a gradient of 7 per cent. A. H.

316. *Vallejo, Benicia, and Napa Valley Single-phase Railway.* **G. T. Hedrick.** (Elect. Journ. 3. pp. 657–658, Nov., 1906.)—This single-phase railway is supplied with power by the Bay Counties Power Co. The transmission takes place in the form of 3-phase, 60-∿ currents. The frequency is changed by means of two motor-generator sets, each consisting of a 585-h.p., 3-phase, 2,200-volt, 60-∿ induction motor direct-coupled to a 400-kw., 2-phase, 25-∿, 6,600-volt generator. The cars are all equipped with multiple-unit control. At first the trolley wire was supplied at 750 volts, but this has recently been changed to 3,300 volts, and the author gives details of how this was done without interrupting the service. A. H.

317. *Electric Traction on the Vienna Underground Railway.* **K. Rosa** and **V. List.** (Elektrotechnik u. Maschinenbau, 24. pp. 881–887, Nov. 4; and pp. 901–908, Nov. 11, 1906. Elekt. Bahnen, 4. pp. 629–633, Nov. 24; 652–658, Dec. 4; and pp. 670–675, Dec. 14, 1906. Electrician, 58. pp. 443–446, Jan. 4, 1907. Abstract. Écl. Électr. 50. pp. 51–55, Jan. 12, and pp. 80–88, Jan. 19, 1907.)—The authors describe the arrangements adopted by F. Křižík on the experimental section of the Vienna underground railway. A 3-wire continuous-current system is in use, with 3,000 volts across the outers [Abstract No. 105 (1906)]. The track is a double one throughout. Between the two tracks are erected centre-poles carrying cross-arms from which the two outer conductors are flexibly suspended on each side (there being a total of 4 conductors, two over each track). Current is collected by two sliding bows arranged at opposite corners of the roof of the locomotive. Each locomotive is 7,850 mm. long between buffers, is two-axled, has a wheel-base of 3,000 mm., and wheels 1,200 mm. in diam.; its weight is 29 tons. Each axle is provided with a spur-wheel at one end, and is driven by two motors arranged on opposite sides of it, the pinions on the motor shafts being geared with the spur-wheel at opposite ends of a horizontal diameter. By means of this arrangement, the axle is only subjected to torsional stress, and racing of one of the series-connected motors at the expense of the other is prevented. When the speed is 25 km./hour, each motor develops 200 h.p. The 4-pole motors are wound for 750 volts each, and the pair driving an axle are permanently connected in series. Thus each locomotive has two motors in series on each side of the 3-wire system, the middle point being connected to the rails. The arma-

tures are wave-wound, and run quite sparklessly under all conditions of load, owing to their careful design; there is only one turn per coil, and the pole-shoes are specially shaped to counteract the effects of armature reaction. The armature core is 51 cm. in diam., has a net length of iron of 27·2 cm., and 46 slots, each 1·72 cm. × 3·64 cm. There are 550 conductors, each 13 × 1·2 mm. The air-gap length is 0·5 cm. The 275-part commutator is 41 cm. in diam. and 18 cm. long. There are 4 sets of brushes, and 4 brushes per set, each 1·1 × 4 cm., so that each brush covers 2·8 segments. Details are given of various accessories, such as the controller and its connections, the overload cut-outs, lightning arresters, motors driving the air compressors for working the brakes, &c. A. H

318. *Gas-Producer Engine Plants at Boston Elevated Railway.* P. Windsor. (Street Rly. Journ. 28. pp. 707–712, Oct. 20, 1906. Abstract of paper read before the Amer. Street and Interurban Rly. Engin. Assoc., Oct., 1906. Eng. Record, 54. pp. 481–482, Oct. 20, 1906. Electrician, 58. pp. 180–181, Nov. 16, 1906. Abstracts.)—Tests with two power-gas plants, one at Medford and the other at Sommerville station of this railway are described. The Medford plant has Wood producers and auxiliaries, double-acting two-cycle Koerting engines and Crocker-Wheeler generators; whilst the Sommerville station has a Loomis-Pettibone gas plant, American-Crossley engines and Crocker-Wheeler generators, a diagram of plant of each station being given. The test principally relates to the latter. It was continued for 30 days at 16 hours per day with an engine load-factor of over 70 per cent. The average coal consumption was 1·31 lbs. per kw.-hour, including all fuel required, or about half the fuel required for a steam plant. The reliability and efficiency are held to be proved, and the water consumption is about 200 lbs. per kw.-hour, as against 600 to 900 lbs. for a condensing steam plant. Attendance is easier with the gas plant, and only 15 to 20 min. are required for starting, as against 1 to 1¼ hours for steam plant. The prime cost is slightly higher with gas plant, but is soon balanced by economy and maintained efficiency. Troubles with premature ignition and noisy exhaust were experienced and overcome. F. J. R.

319. *Multiple-Unit System of Control on the Cologne-Bonn Railway.* R. Rinkel. (Elekt. Bahnen, 4. pp. 469–472, Sept. 4; 493–496, Sept. 14; 509–515, Sept. 24, and pp. 530–535, Oct. 4, 1906. Electrician, 58. pp. 129–130, Nov. 9, 1906. Abstract.)—An illustrated description of the multiple-unit system worked out by the Siemens-Schuckert Co. for use on the 1,000-volt continuous current railway from Cologne to Bonn [see Abstract No. 475 (1906)]. The current taken by a train of 4 cars is 600 amps. The system consists essentially of a set of contactors operated by magnets which are energised by means of a simple form of controller from a 60-volt secondary battery having a capacity of 8 amp.-hours. The charging of the battery is normally effected by putting it in series with the motor working the compressor. The controlling circuits, which consist of 14 wires, are carried throughout the entire length of the train, a multiple connector cable being used to connect each car to its neighbour. A. H.

320. *Tests of New Power Plant for Railway and Lighting Service in Waltham, Mass.* (Street Rly. Journ. 28. pp. 1174–1179, Dec. 29, 1906.)—The article describes the new power plant recently installed, which supplies railway power in part to the Newton Street Railway Co., the Lexington and

Boston Street Railway Co., and the Newton and Boston Street Railway Co., besides generating energy for sale in Waltham City. The present generating equipment consists of two 500-kw. 60-cycle, 2,300-volt, 2-pole, 3-phase, 3,600-r.p.m. Westinghouse-Parsons turbo-alternators; also two 25-kw. 125-volt exciters. A 2,000-kw. and a 1,500-kw. turbo-alternator will be installed to operate at 6,600 volts. Railway power for the lines in the immediate vicinity of the power-house is at present drawn from a 400-kw. synchronous motor generator set. Particulars of the condensing equipment and of the steam piping system are given. On the switchboard the special feature of the totalising panel on the railway board is the use of both a Thomson recording wattmeter and a Bristol recording ammeter. The first alternator tested was a 500-kw., 60-cycle, 2,300-volt, 3-phase machine, of the enclosed type, having small brass hand-hole covers in the end shields, which afforded easy access to parts of the winding. Mounted on the shaft were two small brass fans, located one on each side of the rotating member. The normal speed is 3,600 r.p.m. The uniform air-gap measured 1¼ in. In making the saturation and core loss test on open circuit the turbo-generator was belted to a continuous-current motor, when the following readings were taken:—

MOTOR (525 VOLTS C.C.).			GENERATOR (3,600 R.P.M.).		
Amps. Armature.	Amps. Field.	Kw.	A.C. Volts Armature.	Amps. Field.	Core Kw.
52	3·35	27·3	0	0	—
55	3·35	28·8	395	8	1·57
59	3·35	31·0	795	15·25	3·77
64	3·35	33·6	1,192	23	6·3
69	3·35	36·2	1,600	30·8	8·9
77	3·35	40·5	1,995	39	13·2
52	3·35	27·3	0	0	—
85	3·35	44·6	2,300	46·5	17·3
100	3·35	52·5	2,700	58·2	25·2
110	3·35	57·8	2,865	65	30·5
52	3·35	27·3	0	0	—
52	3·35	27·3	0	0	0
55	3·35	28·8	63·8	12·2	1·3
60·5	3·35	32·3	126·5	24·5	5
68	3·35	35·7	154	30·2	8·4
77	3·35	40·5	191	37·4	13·2
9·5	3·35	5	Belt off	—	—

The second part of the above table relates to the short-circuit core loss and impedance test. In making this the armature leads were short-circuited through an ammeter, and the field current increased from zero to a sufficient amount to have the amps. flowing through the armatures equal to about 150 per cent. of full-load current. On account of local conditions it was not feasible to run the machine under full load, and it was therefore necessary to substitute a compromise heat run, which consisted of a 1/9-hour short-circuit heat run at 125 per cent. load and a ½-hour open-circuit run with fields excited to give 10 per cent. above the normal rated voltage of the machine. The temperature-rises fell within the guarantees. The rise in temperature by resistance measurement after the over-load run was determined to be 40° C. in

phases 1 and 2 of the armature, the field-winding rise by resistance being 88·4° C. above the surrounding air (25° C.). From the saturation and impedance curves the regulation was computed, the results for full load at power-factors of 1·0 and 0·8 averaging 10 and 25 per cent. respectively. For Machine I. the armature resistance per leg was 0·0506 ohm cold and 0·0575 ohm after the heat run. The field resistance was 1·27 ohms cold and 1·48 ohms hot. For Machine II. the armature resistance per leg was 0·0527 ohm cold and 0·0595 ohm after a run of 9 hours at 25 per cent. over-load, temperature-rise 88·5° C. The field resistance cold was 1·89 ohms; hot, 1·629 ohms (voltage was 10 per cent. above normal for 4 hours), temperature-rise 45° C. Two sets of steam consumption tests were made on one 500-kw. turbine, one without superheat and the other with 100° superheat. Complete figures for the test conditions are given; the steam consumptions obtained were as follows:—

500-Kw. Turbine.	No Superheat.			100° Superheat.		
Throttle pressure, lbs. gauge per sq. in.	154·6	150·7	149	151·9	151·5	146·2
H.P. inlet pressure, lbs. gauge per sq. in.	55·2	91·6	120	55	120	132·9
Vacuum referred to 30-in. barometer	28	28	27·57	28	27·77	26·59
Lbs. steam per b.h.p.-hour	15·44	14·12	13·69	13·83	12·41	13·60
Character of test in per cent. of full load	50	75	Full	50	Full	125
Guaranteed consumption at 28 in. vacuum and 175 lbs., lbs. per b.h.p.-hour	15·7	14·8	14·3	14·3	12·9	—

The speed-variation test gave the figures: No load to full load (either way), 3·71 per cent.; no load to 1¼ load (either way), 4·50 per cent. A. G. E.

821. *Lighting Development at Keene, N.H.* (Electrical World, 48. pp. 1050–1058, Dec. 1, 1906.)—A map of the distribution system carried out by the Citizens Electric Co. is given, showing that the centre of load was practically the city centre, and the business district was not extended much beyond ½-mile circle. Single-phase lines are used for arcs and 3-phase for incandescent lighting. Some 3-phase power circuits are run to factories, but the entire system is operated from main power-station bus. The load is shown by curves to have been barely 15 per cent. in the summer months, rising to 28·7 per cent. in Oct., 1906. The plant consists of two 250-h.p. automatic water-sealed gas producers with scrubbers but no holder, as the rate of gasification of anthracite pea-coal (averaging 12,850 B.Th.U. per lb.) is controlled automatically by a regulator which proportions the blast to the demand for gas from the engines. The engines are Westinghouse 3-cylinder vertical single-acting, aggregating 400 h.p. and operating direct-connected 3-phase alternators in parallel upon a common bus-bar. The fuel consumption with a load-factor of 28 per cent. for the day was 1·8 lbs. per kw.-hour, corresponding to a heat efficiency from coal pile to bus-bar of 15·4 per cent. The total cost of working during the summer months was 1·7 cents per kw.-hour, on an average output of only one-seventh of the plant capacity. F. J. R.

822. *Track Construction and other Improvements of the Tri-City Railways.* (Street Rly. Journ. 29. pp. 4–7, Jan. 5, 1907.)—Extensive improvements with the electric railway system are being made by J. G. White and Co., who have recently acquired the railway, gas, and electric light properties of Rock Island and Moline, Ill., and Davenport, Ia. Three separate systems were employed at the time of purchase, and the work of reconstruction will consist in centralising the power supply for all of the systems, reconstructing and rebuilding a considerable portion of the track, together with other improvements dependent upon this. The station in Moline is being provided with sufficient

generator capacity to furnish power for all of the railway and lighting load, and the other stations are being converted into substations. *Track Construction.*—Girder rails were at first employed in the new work, as the city ordinances did not permit of T-rail construction, but after permission being gained to lay 800 ft. of double track with T-rail in paved street, which was done at a point where it would receive the hardest usage from crossing wagons, permission was granted to use the T-rail in all of the new track work in Davenport. The sample track as built consisted of 8-in. 80-lb. T-rails supported by oak ties embedded in concrete. The concrete bed extended 4 in. below and 2 in. above the ties. Nose brick of the "Twin City" type were laid next to the rail, and these, as well as the remainder of the paving brick, were laid on a cushion of sand 1 in. thick. The track construction with girder rails is very similar to that with T-rails. Some special construction work with girder rails was done on one section of the route. When the tearing up of the old track was begun it was found that this track had been laid with wood ties in a bed of concrete. And as this concrete was in such excellent condition and the work of tearing it out would have been endless, a method of construction was devised whereby it was allowed to remain practically undisturbed. At intervals of 5 ft., which was the spacing of the old ties, the new 9-in. girder rails were bolted together by means of anchors consisting of sawed lengths of old girder rails. Each tie was fastened by means of four bolts, and interlocking washers, with its flange uppermost, to the running rail. The rail joints were made in a manner which practically assures of their remaining solid throughout the life of the track. In addition to the two 12-in. bolt plates on either side of the web a T-iron 5 ft. long, made by cutting a 15-in I-beam longitudinally through the middle, was hot-riveted to the under side of the rail. After the rail sections had been bolted and riveted together, a rich mixture of concrete consisting of one part cement to two parts sand was flowed around the ties and around the bases of the running rails. C. E. A.

323. *Turbo-units of* 10,000-*kw. for Brooklyn.* (Street Rly. Journ. 29. p. 154, Jan. 26, 1907. Electrical World, 49. p. 196, Jan. 26, 1907.)—This article deals with the details of the contract placed by the Brooklyn Rapid Transit Co. for additional turbine units in addition to the plant already installed; the units are so far the largest ever placed on record. There are five 10,000-kw. units as well as a large amount of converting, transforming, and controlling apparatus. A new standard is also established in compactness. Over all the turbine measures 24½ ft. in length, 15 ft. in width, and 12½ ft. in height above the floor level. It is designed for a steam pressure of 175 lbs. at the throttle, 100° (F. ?) superheat and 28 in. vacuum, and the units are capable of sustaining their full rated load continuously with a temperature-rise of 35° with power-factor ranging from 90 to 100 per cent. In the event of loss of vacuum from whatever cause, the turbines will automatically "go to high pressure," carrying their full rated load without the assistance of a condenser, this being accomplished by the addition of a secondary admission valve and operated by the governor. The action of this valve is to raise the pressures in the various stages and thus increase the capacity of the machine. Speed variation may be adjusted to a nicety by a distant-control mechanism attached to the governor and operated from the switchboard. The standard rotating-field design will be employed with frame entirely enclosed so as to facilitate forced ventilation and incidentally obviate the noise emanating from high-speed turbines. The surface condenser will be located as usual

directly beneath the power-house basement, together with all the auxiliaries, thus giving a clear engine-room floor. This arrangement likewise permits of the most effective means of carrying out the "unit system" in power-plant design. C. E. A.

324. *New Three-phase Three-speed Locomotives of Italian State Railways.* **B. Valatin.** (Elektrische Kraftbetr. u. Bahnen, 5. pp. 101–107, Feb. 28, 1907.)—Each locomotive is equipped with two 3,000-volt, 15-$\sim$ induction motors, one of which is an 8-pole, 1,500-h.p., and the other a 12-pole 1,200-h.p. one (at one hour's rating; temperature-rise not to exceed 75° C.). The motors may be used either singly or in cascade, the corresponding speeds being 64, 42, and 25·5 km./hour respectively. The weight of the 8-pole motor is 13·4 tons, that of the 12-pole one 11·4 tons. In order to avoid the necessity of introducing starting resistances into the high-voltage stator winding of the 12-pole motor when using the cascade connection, each phase of this winding is subdivided into 3 coils, the coils of each phase being in series and the phases in star when the motor is across the 3,000-volt line; and the coils of each phase being in parallel, and the phases in delta, when the cascade connection is used. This reduces the stator voltage in the ratio of 1 : 5·2. The starting resistance is a water resistance; this is also used for equalising the load on two locomotives coupled to the same train. A. H.

325. *Destructor and Electricity Works.* **A. J. Abraham.** (Elect. Rev. 60. pp. 202–203, Feb. 1, 1907.)—At the Cambuslang Electricity Works 72 tons of refuse are destroyed per week, from which 2,520 units are generated, or about 35 units per ton. As no battery is employed, the destructor is not worked to advantage from the point of view of economy. On 8-hour tests 97 units per ton have been generated with cold feed-water. The author favours the front-feed type of destructor. F. B.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

326. *T-Rail Welding with Expansion Joints.* (Street Rly. Journ. 29. pp. 154–155, Jan. 26, 1907.)—This article refers mainly to T-rail welding by the Lorain Steel Co., and shows an illustration of a joint which is an improvement on those first used. The first T-rail welded in which expansion joints were used was in Brooklyn, on 1,000 ft. of old 65-lb. rail. Only one rail was welded, and ordinary split switch points were used at the ends of the 1,000-ft. section. The longest stretch of T-rail welded is about 6 miles, and expansion joints were furnished every 1,000 ft. In the improved joint, instead of using a number of separate plates for holding the two rails together as heretofore, one plate only is used, extending the full length of the bevel cut. It is considered that this form of joint should give complete satisfaction, in view of the fact that there is no thrust against the point rail as in the case of a split switch, so there will be no great amount of wear against the point. So far the results on all the T-rail welded have been most satisfactory.

C. E. A.

[1] Non-electrical Automobiles are described in the Section dealing with Steam and Gas Engines.

327. *Rail Specifications.* **A. L. Colby.** (Amer. Inst. Mining Engineers, Bull. 11. pp. 629–680, Sept., 1906; Discussion, 13. pp. 118–182, Jan., 1907. Iron and Steel Inst., Journ. Vol. 71, 1906. Paper read at Joint Meeting. Engineering, 82. pp. 170–172, Aug. 3; p. 209, Aug. 10, and pp. 238–240, Aug. 17, 1906.)—Discusses at length American and foreign rail specifications, and frames a specification intended to be sufficiently flexible to cover American rails intended for export in addition to those for home use. The paper ends with a bibliography on rails, from 1870 to date. In the *discussion*, several speakers referred to the phosphorus limit proposed by the author (viz., 0·1 per cent.). With increase of C, P should decrease, and *vice versâ*. **J. E. Stead** also pointed this out, and added that he had found high Mn to be as dangerous as high P. High Mn and high C together are especially to be avoided; rails of this type are very susceptible to change of atmospheric temperature; they are brittle if rolled on a cold day. Mn should not exceed 1 per cent. in rails. **A. Lamberton** thought that rails are subjected to more severe shock in the British mode of construction on chairs than in the American, *i.e.*, the flat bottom of rail resting directly on wood sleepers. **J. E. York** considered a low finishing-temperature of less value for a T- than for a bull-headed rail. The wide base involves great differences of rolling velocity throughout the base, and when the metal is comparatively cold these set up internal stresses in it. F. R.

328. *Rail Corrugation.* (Street Rly. Journ. 28. pp. 1180–1181, Dec. 29, 1906.)—The article is founded upon data supplied by and the opinions of the roadmaster of the elevated division, and the engineer of the Boston Elevated Railway. Measurements of the length and depths of corrugations, and observations of their location, indicate that there are no serious corrugations on track rails which are not protected by guard rails. Hence the corrugations are probably in part caused by the skidding of the inside wheels on curves, aggravated by the bearing of the inside flange against the guard rail. The most serious trouble occurs on the longer radius curves, where speeds are fairly high. Other probable causes of corrugation suggested are imperfect rolling of the rails, loose rails on good foundation, widening of gauge on curves, and imperfect elevation of outer rail. F. R.

329. *Corrugation in Rails.* **R. Braun.** (Zeitschr. Vereines Deutsch. Ing. 50. p. 2128, Dec. 29, 1906.)—The author describes an experimental arrangement which he has employed in investigating the question of the origin of rail corrugations. A 200-h.p. direct-current motor, having a heavy flywheel on the shaft, which could be given peripheral speeds of 0–100 km. per hour, was employed, and a magnetic track brake suspended from a spring balance was, when excited, attracted to the wheel rim; the inner part of the wheel rim was water-cooled. The author comes to no very definite conclusions, but seems to consider it likely that corrugation is set up as a result of momentary variations in the friction-coefficient, giving rise to similar variations in the braking torque, thus stopping the wheels and then letting them roll again on the rails, and so on (these variations not necessarily occurring at the same instant at both wheels of an axle). The first corrugations having been started, these are afterwards amplified since the wheels are generally of uniform weight, and hence have the same vibration periods. L. H. W.

330. *Rail Corrugation.* **R. W. Western.** (Tram. Rly. World, 21. pp. 104–106, Feb. 7, 1907.)—Discusses the origin of the bright patches seen

on tram rails, which are incipient corrugations; they are due to slipping between tyre and rail from any cause which tends to make one wheel move more rapidly than the other. An aggregate of these patches frequently form a crescent-shaped bright area, whose convex side is in the direction of running of traffic. A number of these sometimes arrange themselves in the form of a three-strand rope. These effects are better observed on new rails, and do not appear on railways because of the variety of rolling stock commonly composing trains; but where trains are more homogeneous such accumulated effects, gradually culminating in corrugations, are found to occur. The Eastern Bengal State Railway, which has a heavy coal traffic in trucks of few types of design, suffers from corrugated rails. F. R.

331. *Art of Manufacture of Railway Car Axles.* **H. V. v. Z. Loss.** (Frank. Inst., Journ. 163. pp. 1–30, Jan., 1907.)—Describes the ordinary method of swaging axles under the hammer, and the attempts that have been made to forge axles in dies, including longitudinal and circumferential rolling, the Mercader process, and a method of upsetting proposed by the author. Drawings of the proposed apparatus are given, and estimates of first cost and cost of working are compared favourably with an equivalent hammer plant. The Pennsylvania railroad percentage chemical specification for axle steel is: C, 0·4 (limits, 0·38 to 0·50); Mn, 0·5 (limit, 0·6); P, 0·05 (limit, 0·07); Si, 0·05; S, not over 0·04. The author considers annealing of axles after forging, at 815° to 980° C., preferably the latter, very desirable.
F. R.

332. *Standard Rail Sections for Paved Streets.* **C. G. Reel.** (Street Rly. Journ. 29. pp. 138–144 and 147, Jan. 26, 1907. Paper read before the New York State Street Rly. Assoc.)—In this paper, after considering very shortly the history of the so-called girder rail, the author proceeds to deal with the T-rail section, which not only does away with all the disadvantages of the girder rail, but has many advantages. The chief are, perhaps, as follows: (1) Its symmetrical section, the load coming directly over the centre of the rail; its full deep head, insuring long life, and the unlimited flangeway; also the fact that it is easily spiked to the ties. (2) The long angle-bar joint with T-rail sections is practically perfect. (3) The load being symmetrical, there is no tendency for the tracks to get wide to gauge or to move around in the street, and therefore no tendency for the pavement to become loose along the tracks. (4) The flangeway being gritty, a vehicle turns out of the tracks with the greatest ease. (5) T-rail tracks are less noisy. From these the author next proceeds to set out the still further advantages which the standard rail sections possess over the high T-section: (1) The standard sections are more substantial in every way; they have a larger head, a thicker web, and a wider base, and they realise the maximum efficiency in rail design. (2) The all-important question of joints. (3) The high T-sections have been approved by some city engineers and the standard sections objected to on the theory that these latter are not sufficiently deep for paving, but this objection is done away with as there is no reason why the pavement cannot extend down beneath the base of the rail. (4) The standard sections not being so slim and top-heavy have a way of staying where they are put to a much greater extent than the high T's. (5) From the standpoint of economy—since the mills are able to produce standard T-sections at a considerably less cost per ton than the high sections. The article is well illustrated, and includes data relative to T-rail construction. C. E. A.

333. *Track Construction in Paved Streets.* I. E. Matthews. (Street Rly. Journ. 29. pp. 99–100, Jan. 19, 1907. Paper read before the New York State Street Rly. Assoc.)—The selection of the proper form of track construction for any given street depends largely upon the sort of traffic which will use it. Stone blocks with a correspondingly heavy track construction for a street of heavy traffic, and asphalt or brick might be selected where traffic is light, but in either case a concrete foundation of at least 6 in. in thickness is recommended under the ties. The type of construction best adapted to streets of heavy traffic is the 9-in. full-grooved rail, well tied with Georgia pine ties, spaced 24 in. to 30 in. centre to centre and laid on a 6-in. concrete base. The concrete should be laid at the same time as that for the foundation of the adjoining pavement, and should be carefully tamped under the ties and rails. A fine concrete should be poured round and under the rail in order to give a firm and uniform bearing to the rail. The space between the flange and head of rail should be filled with a Portland cement mortar. The stone blocks resting on 6 in. of concrete complete this construction. A description is also given of a concrete beam construction under the rails, but to render this construction satisfactory the concrete foundations of the track and pavement should be thoroughly bonded together. The author strongly recommends the use of the T-rail, despite the opposition of the authorities to it. He considers it preferable to the grooved rail, because it is cheaper in first cost, and because it ensures the bearing of the wheel squarely over the centre of the base. The base being wide there is no tendency to overturn, and the flangeway formed by the special paving blocks which can now be obtained gives a groove which is as self-cleaning as that of the grooved rail. Very little wear also can take place on the ordinary grooved or girder rail before the cars are running on the wheel flanges. With the T-rail, however, the amount of wear that can take place before the track is entirely worn out is independent of the car-wheel flanges. Some figures are given with regard to the cost of the T-rail, and the author concludes by suggesting the high T-rail with wooden ties on a concrete base, or steel ties on the concrete stringers, as the ideal track construction in paved streets; excepting, however, in streets of heavy traffic, where the grooved girder rail would be superior on account of the better protection afforded to the pavement adjacent to the rail. C. E. A.

ELECTRIC LAMPS AND LIGHTING.

334. *Improvements in Mercury Vapour Lamps.* (Elektrotechnik u. Maschinenbau, 24. pp. 771–772, Sept. 23, 1906.)—Most of the patented improvements reviewed deal with electrical or mechanical variations of the starting arrangements. The Siemens-Schuckert works, of Berlin, however, describe in D.R.-P. 168,515 a means for obtaining a less purely monochromatic light from mercury vapour lamps, especially suitable for quartz lamps or lamps made of glass not very absorbent for the rays. The rays which emerge from the lamp bulb or tube are caused to fall upon a fluorescent screen combined with a diaphragm of ground glass in such a way that the rays of short wave-length are converted into visible radiation by their action on the fluorescent substance. In another patent (Fr. Pat. 359,486) a method of increasing the efficiency is claimed by the firm of W. C. Heraeus. It is pointed out that hitherto it has been assumed that the efficiency decreases with increase of pressure (lower vacuum, *i.e.*, greater pressure-fall in the light-column). It has, however, been

found that if the lamp be run much above its usual load, a bend in the efficiency curve occurs and the efficiency becomes more favourable than the highest values observed at lower loads. An efficiency of 0·17 watt per candle [Hefner ?] was obtained. The load was in this case increased to 25–30 volts per cm. of the light-column, about 25–30 times the usual load for the highest efficiency. Under these conditions, for the usual voltages (110–220 volts) the light-column is only 6–15 cm. long, and this is considered to be a great advantage as compared with the usual lamps of 50–200 cm. in length. Nothing is said about the effect of the reduction of cooling (radiating) surface involved.

L. H. W.

335. *The Standard Specification for Carbon Glow-lamps.* **L. W. Wild.** (Elect. Rev. 60. pp. 282–283, Feb. 15, 1907.)—A detailed criticism is made of the British Standard Specification for Carbon Filament Glow-lamps [Abstract No. 216 (1907)]. With reference to the lamp caps—as the insulation resistance frequently goes from 0 to infinity in a few sec. when tested with an Evershed ohmmeter—the voltage and the duration of test should have been specified. It would have been better to omit the question of vacuum from the specification, as the committee apparently were unable to specify any standard method of testing. The measurement of the m.h.c.p. instead of the true c.p. is adversely criticised. The lamps selected for the life test have to start at a standard efficiency. This is the proper method of rating when the object of the test is to ascertain the quality of the filament, but the test should end when the c.p. has dropped to 80 per cent. of its original value, not when it has dropped to 80 per cent. of its rated value. A lamp rated as 16 c.p., for instance, is allowed to burn until its c.p. has fallen to 12·8, provided that its initial c.p. lies between 14 and 18. This unduly favours lamps the initial c.p. of which is greater than 16. It is also pointed out that an error of 1·5 per cent. in the last c.p. measurement makes a difference of ±10 per cent. in the measured "life" of the lamp. The life-test is inequitable also as the m.h.c.p. instead of the m.s.c.p. is measured. The author finally indicates how an equitable specification might be made. A. R.

336. *Tungsten* [*and Tantalum*] *Lamps.* **Bainville.** (Soc. Int. Elect., Bull. 7. pp. 115–125, Feb., 1907.)—A brief *résumé* of present knowledge on the subject. **P. Janet** gives information regarding the use of tantalum lamps on the Paris lighting system. At the Laboratoire central systematic life tests have been carried out, and the lamps have been used on alternating-current circuits, in spite of the makers' advice to only employ direct current. Tests made on three lamps which had been in service since the middle of October last and had burned 300–400 hours showed, as a mean, 39·5 watts, 19·5 horizontal candles; watts per horizontal candle = 2·05. Sharp had found the spherical reduction factor to be 0·70–0·76, for new lamps. Janet finds that for lamps which have run several hundred hours the value of this factor is much greater; after 700 hours it was found to reach 0·86 and 0·90; this result is attributed to the influence of the deposit on the glass walls in altering the horizontal intensity. The results obtained with an "osram" (tungsten) lamp for 110 volts and having four filaments are given. This took 34 watts, giving 26 horizontal candles (or 21·2 mean spherical), the watts per candle being 1·3 and 1·6 for the two intensities respectively. The mean coefficient of variation of luminous intensity per volt is + 0·033, nearly the same as that of the tantalum lamp, 0·036. Fuller results dealing with life tests are to be communicated later on.

L. H. W.

337. *Determination of Mean Horizontal Candle-power of Glow-lamps.* **F. Uppenborn.** (Elektrotechn. Zeitschr. 28. pp. 139–142, Feb. 14; and pp. 168–171, Feb. 21, 1907.)—Four methods are in use for determining the m.h.c.p. of glow lamps. The first is the direct method, the m.h.c.p. being obtained from a number of measurements along different directions at equal angular distances apart. The second method is the polygonal mirror method of the Verband Deutscher Elektrotechniker. In this, a polygonal mirror is placed over the zero of the photometric bench, and 9 cm. in front of it is arranged a standard of known m.h.c.p. The photometer is placed at the scale division corresponding to this m.h.c.p., and is rigidly connected with a comparison lamp which is arranged to be at a distance of from 54 to 66 cm. from it. The voltage of the comparison lamp is then adjusted until balance is obtained, and this voltage is maintained constant throughout the subsequent operations. The standard is now removed, and the lamp to be tested put in its place. The photometer, together with the comparison lamp rigidly attached to it, is now moved about until the position of balance is found, when the m.h.c.p. of the lamp under test is read off on the scale. The third method is the polygonal mirror method of the Siemens-Halske Co., in which a polygonal mirror is arranged at each end of the bench, and the photometer is moved without the comparison lamp; otherwise the procedure is similar to that used in the Verband method. The last method is that of rotating the lamp during the test; this is very largely used in America. The author has carried out elaborate investigations with a view to comparing the relative values of the last three—*i.e.*, the indirect—methods. He finds that the second and third methods give equally good results. The rotating lamp method cannot in general be relied upon, owing to the deformation of the filament during rotation; and it gives correct results only when the effects of rotation on the standard and the lamp under test are similar [see Abstract No. 1457 (1906)]. A combination of the polygonal mirror with the rotating lamp method does not result in any appreciable improvement. A. H.

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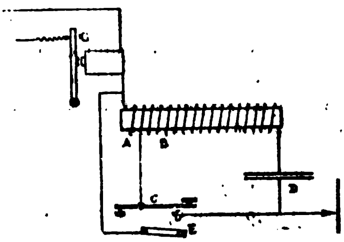
338. *Long-distance Transmission Lines.* **C. P. Fowler.** (Elect. Journ. 4. pp. 79–82, Feb., 1907.)—Tables are given showing the total voltage drop in transmission lines, at power-factors ranging from 0·6 to 1·0, and with different percentages of the resistance and inductance volts; and the approximate kilowatts, at a power-factor of 0·85, which may be transmitted over various distances and at various p.d.'s, when the inductance volts in the line are various percentages of the total voltage. A. H.

339. *Calculation of Voltage Drop in Tramway Systems.* **E. Goolding.** (Tram. Rly. World, 21. pp. 102–103, Feb. 7, 1907.)—The author gives a table intended to facilitate the calculation of the voltage drop along the track, third rail, and trolley wire, and explains the use of the table by a number of numerical examples. A. H.

TELEGRAPHY AND TELEPHONY.

340. *Field's New System of Telegraphy.* (Elect. Rev., N.Y. 50. p. 45, Jan. 12, 1907.)—The inventor, S. D. Field, arranges an induction coil AB and condenser D in his circuit, as shown in the Fig. The battery at the other end of the line charges the condenser through the induction coil when the key is open. On closure of the key the energy stored in the condenser acts inductively upon the primary winding A, setting up currents in a direction to assist the line battery to do its work. On an artificial circuit purposely made faulty the arrangement is said to work well.



E. O. W.

341. *The Continuous Production of High-frequency Oscillations.* **R. A. Fessenden.** (Electrician, 58. pp. 675–677, Feb. 15, and pp. 710–712, Feb. 22, 1907.)—The author gives a brief and partly historical *résumé* of continuous methods of producing oscillations, chiefly confined to his own work. The method of Thomson [Abstract No. 99 (1907)] is maintained to be an arc method, and this view is supported by quotations from experimental results with an optical apparatus [revolving mirror (?)]; these experiments were, however, only carried out in 1901, and showed an upper limit of frequency at 120,000 per sec. The author now apparently, as far as can be gathered from the context, uses a modification of this method in which he has abandoned the similar spark-balls of Thomson and has substituted water-cooled electrodes in compressed nitrogen, thus making use of the "gas discharge," according to the author, and not the arc. The remainder of the paper is mainly a criticism of the work of others and some notes on the application of such oscillations to wireless telephony. Incidentally an attack is made upon Fleming's book "Electric Wave Telegraphy." **J. A. Fleming.** (Ibid. pp. 782–784, Feb. 22, 1907.)—Fleming refutes many of Fessenden's criticisms, and points out that the sketchy nature of the information given by Fessenden, and the absence of experimental data, renders it not yet certain that the phenomena described actually occur. He calls for data showing that the oscillations obtained either by the Thomson [original (?)] or the Brown method have a decrement of zero value. L. H. W.

342. *Diurnal Disturbances in an Earthed Wireless Telegraph Receiver System.* **K. E. F. Schmidt.** (Phys. Zeitschr. 8. pp. 183–186, March 1, 1907.)—While investigating the effect of sunlight on wireless transmission the author, using an inclined aerial of 80 m. in length connected to the water main, a 2-litre jar capacity and a barretter, received the waves from his transmitting station 8·5 km. distant. This latter was operated with a spark of constant intensity (found not to vary during 4 hours' continuous experimenting). A remarkable variation in the strength of the received signals was observed, the variations beginning generally at midnight. Resonance curves are given, plotted from

the barretter (galvanometer) readings as ordinates and the contacts of a tuning inductance (practically proportional to the inductance added) as abscissæ. These show that the resonance curve is constantly changing. Slight variations occur from 10 p.m. till midnight, after which the larger disturbances appear; these were followed till 2 a.m. On substituting for the earth connection a counterpoise (the barretter being arranged in the current loop), these disturbances were absent, the resonance curve remaining practically unaltered. The increase of received energy that occurs at midnight in the case of the earthed system, is attributed to the effect of the decrease of the atmospheric ionisation, which sets in after sunset. A smaller disturbance is visible about midday. The curves show a parallelism with those of atmospheric ionisation, but the maxima of disturbance coincide with the times of the *maxima* of atmospheric ionisation. L. H. W.

343. *Central Battery Telephone Systems.* **E. Neuhold.** (Elektrotechn. Zeitschr. 28. pp. 77–79, Jan. 24, 1907.)—The author describes the common faults pertaining to these systems, both those inherent in the systems themselves and those occasioned by disturbances from without. Three arrangements in use on the Continent are diagrammatically explained, and the effect and degree of disturbance in each occasioned by the propinquity of a single-phase circuit of 15,000 volts and 50 cycles are dealt with. Experiments were made with each system, (1) in position of rest, (2) when the wanted subscriber is being called, and (3) when the two subscribers are connected. As a result of his investigations the author favours a metallic circuit with local battery. E. O. W.

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344. *International Wireless Telegraph Convention.* (Journ. Télégraph. 31. pp. 49–64, Feb. 25, 1907. Supplement. Elektrotechn. Zeitschr. 27. pp. 1139–1143, Dec. 6, 1906. Electrician, 58. pp. 339–340, Dec. 14, and pp. 359, 381–383, Dec. 21, 1906. Translation.)—The text of the Convention with the service regulations.

345. *Apparatus for Wireless Telemechanical Control.* **G. Gabet.** (Comptes Rendus, 144. pp. 74–76, Jan. 14, 1907. Ind. Élect. 16. pp. 69–70, Feb. 10, 1907.)—An outline of an arrangement comprising a momentarily delayed contact-maker. L. H. W.

346. *Multiple Spark-gaps in Wireless Telegraphy.* **W. B. v. Czudnochowski.** (Elektrotechn. Zeitschr. 27. pp. 1173–1174, Dec. 13, 1906.)—Referring to an article dealing with recent improvements in the "Telefunken" system [Abstract No. 385 (1906)], the author points out that he had some time previously described the arrangement of a multiple spark-gap in which the capacities are charged in parallel and discharge themselves in series [Abstract No. 1989A (1905)]. He now gives a brief account of the action in such an arrangement. L. H. W.

347. *Tuning of Wireless Telegraph Transmitters. Reply to Slaby.* **M. Wien.** (Phys. Zeitschr. 8. pp. 10–18, Jan. 1, 1907.)—A further article in which the author formulates more clearly his grounds for challenging Slaby's results [see Abstract No. 1377 (1906)].

348. *Wireless Telephony.* **R. A. Fessenden.** (Elect. Rev. 60. pp. 251–253, Feb. 15; 327–329, Feb. 22, and pp. 368–370, March 1, 1907. Scientific American, 96. pp. 68–69, Jan. 19, 1907.)—An outline of the methods employed and the results obtained by the author. L. H. W.

SCIENCE ABSTRACTS.

Section B.—ELECTRICAL ENGINEERING.

APRIL 1907.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

349. *Improved de Laval Steam Turbine.* (Mech. Eng. 19. p. 285, March 2, 1907.)—Instead of fixing the nozzles in a diaphragm of the steam chest or casing of the turbine and controlling each one by a stopcock, the nozzles or tapered passages are formed in a plate, which is covered by an annular movable plate having alternate slotted and solid portions opposite the ends of the nozzles. By means of a worm-wheel acting on a rack on the outer circumference of this movable plate any number of the steam-holes leading to the nozzles may be uncovered or shut off to suit the power desired. The nozzles are arranged upon one pitch circle, but the apertures in the covering plate may be on two or more pitch circles. The improvements are illustrated by woodcuts, and are due to A. Greenwood and K. Andersson. F. J. R.

350. *A.E.-G. Steam Turbines.* **O. Lasche.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 885–888, March 9, 1907.)—This paper forms a supplementary communication to the former detailed one [Abstract No. 1268 (1906)], and shows the advance which has been made since then. It is pointed out that the best of large-size piston engines have a steam consumption of 6·7 kg. per kw.-hour (300° C. steam temperature), which figure has been attained by the 5,000-h.p. engines in the Moabit (Berlin) Works. The measurements were in this case naturally obtained from the i.h.p. A steam consumption of 6·7 kg. per kw.-hour has never hitherto been attained with steam turbines which have been running for some time, but the A.E.-G. turbines of 1,500 and of 5,000 h.p. have in the course of tests shown a consumption of 6·7 kg. and 6·0 kg. per kw.-hour respectively at 300° steam temperature, and in the case of the larger size 5·5 kg. [estimated only] with 350° steam temperature. In the case of power stations the vacuum attainable with the quantity and temperature of the available water is often much higher than is worth seeking for in the case of piston engines. As regards superheating, the turbine has one marked advantage, namely, the exceedingly compact construction, owing to which it is often possible to work with a loss of 20° C. between boiler and turbine, as compared with 50° C. in the case of piston engines. The chief results are given below. The steam consumption figures are also converted into

i.h.p. figures for comparison with a piston engine; these results are also given graphically. The steam consumption curve given is no real curve, but represents the consumption which an equal-sized piston engine would have to have if its steam per kw.-hour were the same as for the turbine. The approach of this curve to the curve of theoretical steam consumption, particularly at very small loads, shows that the generally accepted idea that at low loads the steam consumption of a turbine increases more rapidly than in the case of a piston engine, is erroneous. For this type of turbine the reverse holds. The efficiency of the generator is taken as 93 per cent., that of the piston engine at 94 per cent.

3,000-KW. (5,000-H.P.) TURBINE; 1,500 R.P.M.; 12 ATMOS. STEAM PRESSURE (ABOVE ATMOSPHERIC); POWER REQUIRED FOR CONDENSATION, 54 KW. (73 E.H.P.).

Date. 1906.	Time. p.m.	Number of Nozzles.	Steam Temp. °C.	Output at Terminals (not deducting Condensation). Kw.	Steam per Hour.		
					Excl. Condensing, Incl. of Excitation. Kg. per Kw.-hour.	Incl. Condensing and Excitation. Kg. per Kw.-hour.	(Calculated) Kg. per I.H.P.
30/10	9.18–9.30	4	205	0	—	—	(3·51)
28/10	8.0–8.30	4	282	1149·1	6·68	7·01	(3·80)
28/10	9.0–9.35	6	270	1189·7	6·79	7·10	(3·89)
29/10	10.25–11.25	6	309	1896·2	6·02	6·20	(3·74)
29/10	11.30–12.0	8	306	1908·6	6·11	6·29	(3·80)
29/10	2.30–3.05	8	315	2554·2	5·78	5·90	(3·72)
29/10	9.15–9.45	10	311	3169·0	5·79	5·89	(3·80)
29/10	5.35–6.15	12	310	3202·7	5·91	6·00	(3·88)
30/10	2.05–2.40	12	323	3765·8	5·82	5·90	(3·86)

Results of other tests, made in some cases by the A.E.-G. and in others by the Berlin Electricity Works, are also given. L. H. W.

351. *Kerr Steam Turbine.* C. V. Kerr. (Power, 27. pp. 146–149, March, 1907.)—This turbine is constructed on the Pelton water-wheel design, each disc with its double-cup form of buckets and jet nozzles being enclosed in a separate compartment, the compartments forming stages in the range of steam pressures employed. The use of several stages involves a moderate speed of rotation, so that direct coupling is employed. There is no end thrust with this form of turbine, and no trouble with leakage losses through clearance spaces, and consequently this turbine is amenable to high steam pressure and superheat. The throttling type of governor is used, a very simple form being illustrated. The effect of this arrangement is found to be a flat steam-consumption curve. A typical stress diagram for the governor is given. Various details of the turbine construction are illustrated by photographs, and the illustrations also include photographs of complete machines coupled to dynamo, centrifugal pump, and blower. The steam efficiency at different percentages of load is shown by the following figures:—

Load per cent.	100	75	50	25
Kerr 50-kw. turbine, steam efficiency per cent.[1]	100	76·3	58·3	29·6

[1] Stated as percentages of the most efficient load.

For blast pressure blowing a steam gauge attached to the valve case below the governor valve enables the blast pressure to be controlled, a calibrating diagram showing the relation between steam and blast pressures, and r.p.m. and blast pressures being given. This form of turbine is independent of water carried over by the steam. F. J. R.

852. *Test of an Exhaust-steam Turbine.* (Glückauf, 43. pp. 71–74, Jan. 19, 1907. Communication from the Dampfkessel-Überwachungs-Verein for Mines in the Essen district.)—At the Zollverein mine a Rateau low-pressure exhaust steam turbine has been installed to meet the demand for power, in spite of the increased first cost as compared with a high-pressure turbine. The Verein has carried out tests on this turbine, in which actual conditions were as nearly as possible realised by taking live steam from the lifted exhaust valve of a winding engine and then passing it through the main to the accumulator, about 100 m. distant, where it had to pass through the water contained in the regenerator. This was necessary as the test could only be made during the night-shift, when sufficient exhaust steam was not available. The steam consumption was determined from the weighed condensed steam, and the 3-phase generator coupled to the turbine was connected to the bus-bars, from which an electrically-driven compressor was operated, while a further branch contained a water resistance. The power was measured by the 2-wattmeter method. The chief results are given below.

Duration of test, hours	1¼	1	1	1
Vacuum, per cent.	93·46	92·24	92·32	88·29
Admission pressure, atmos. abs.	1·004	1·095	1·094	1·155
Revs. per min.	1,491	1,490	1,496	1,481
Exciter, kw.	4·4	5·95	8·09	7·77
Three-phase output, kw.	433·0	728·35	960·0	1112·0
Cos ϕ	0·95	0·96	0·96	0·96
Steam per kw.-hour, kg.	18·6	15·94	14·77	14·34

The three steam winding engines which are normally to serve as source of exhaust steam generally yield 16,000 kg. steam per hour. L. H. W.

853. *Dependence on Pressure and Temperature of the Isopiestic Specific Heat of Steam.* **O. Knoblauch** and **M. Jakob.** (Mitteil. über Forschungsarbeiten des Vereines Deutsch. Ing. No. 35 and 36. p. 109 *et seq.*, 1906. Abbreviated in Zeitschr. Vereines Deutsch. Ing. 51. pp. 81–88, Jan. 19; and pp. 124–131, Jan. 26, 1907. Communication from the Laborat. f. techn. Physik der kgl. techn. Hochschule, München.)—This is the complete paper referred to in Abstract No. 124A (1906). Steam at constant known pressure is mechanically freed from water by screens of copper wire, then passed into an electrical superheater, where it is perfectly dried and raised to an observed temperature, then passed through another electrical superheater, wherein it absorbs energy at a known rate and is further superheated through an observed range of temperature, and finally condensed and weighed. Detailed descriptions are given of the two superheaters, the precautions used to ensure the perfect drying of the steam—a most difficult operation—and the methods of estimating the radiation loss of heat and of measuring the heat absorbed. The isopiestic specific heat of steam for any given temperature is found to increase with the pressure, and the more near it is to saturation: for any given pressure it diminishes as the temperature rises from the saturation-

point to a minimum and then increases, the minimum occurring at higher temperatures for higher pressures: for zero pressure it is not constant but increases with the temperature, and the more the higher the temperature; in the immediate neighbourhood of saturation it is practically given by $0\cdot41 + 2\cdot52 \times 10^{8}/(365 - t)^{4}$, where t is the temperature in degrees C. R. E. B.

354. *Water-tube Boiler.* (Engineer, 103. p. 46, Jan. 11, 1907.)—This boiler, made by Galloways, Ltd., Manchester, has headers larger in section than is usual with boilers of the Babcock-Wilcox type, and three vertical tubes, instead of one, connect each header with the horizontal drum above. In the back headers the rearmost of these three tubes, placed midway between the other two, is carried down inside the header to near the bottom in order to ensure a supply of water to the tubes nearest the fire, to prevent their collapse and fracture. F. J. R.

355. *Design of Lathe Journals.* **J. T. Nicolson** and **D. Smith.** (Engineer, 102. pp. 466–468, Nov. 9; 522, Nov. 23; 541, Nov. 30, 1906, and 103. pp. 127–128, Feb. 8, 1907.)—This subject is dealt with in the course of a series of articles on "Machine Tool Design." The author discusses the subject of spindle and other friction and lubrication, and utilises some little-known results of Continental workers. It is shown qualitatively that the pressure under which oil must be supplied is greater for low than for high speeds, and that the positions of maximum and minimum oil pressures vary with speed. It is decided to use for design the formula $v_0 = Cp\theta$ with $\theta = 1/80$. When written $\theta_c = 80v_0/p$ it gives the critical value, θ_c, of the rise of temperature above which under the given conditions as to surface speed (v_0 ft. per min.) and bearing pressure (p lbs. per sq. in.) there will be danger of the oil leaving the bearing and allowing metallic contact. F. R.

356. *Influence of Central Station Loads on Smoke Production.* **C. E. Lucke.** (Power, 27. pp. 150–155, March, 1907.)—Even the best arrangements of furnace and stoker for producing smokeless combustion are liable to be upset by sudden and violent fluctuations in load such as are illustrated by the day charts from a street railway power-house which accompany the paper. The same conditions of service are not found in any other kind of power-house, as the operators there have no knowledge of what load fluctuations they will have to meet, and these fluctuations react upon the boilers, involving the necessity of means for rapidly controlling the fires. This affects both furnace design and kind of coal, and only a gas-carrying bituminous coal permits of rapid changes in combustion. The load curves of one station illustrated show an output of 18,000 kw. at 6 a.m., varying up to about 38,500 kw. at 8 a.m., with constant variations throughout the day, at one time delivering 38,500 kw., which dropped in 1 min. to 17,500 kw., and again altering from 42,000 to 18,000 kw. within 5 min. At 12 o'clock midnight there were 14 boilers in service, and 42 boilers with fires banked, while at 6 a.m. there were 49 boilers in service, the output being then 17,000 kw., and at 9 a.m. the output changed to 43,000 kw. with the same number of boilers working, and so on. Under the actual conditions, and until some thermal-energy or electrical-energy storage device is invented, the production of smoke is at times unavoidable. Storage batteries and thermal storage tanks are not universally applicable or satisfactory, and even gas-firing has not at present been made available in such a shape as will avoid existing difficulties. [See also next Abstract.] F. J. R.

357. *Smoke Prevention in Factories and Electric Supply Stations.* **J. B. C. Kershaw.** (Soc. Arts, Journ. 55. pp. 518–518; Discussion, pp. 518–522, March 22, 1907.)—Deals shortly with the principles of smokeless combustion and with practical methods of smoke prevention, referring to Wye Williams' early notice of the subject in "The Combustion of Coal," and advocates an organisation on the lines of the Hamburg Smoke Abatement Society. In the *discussion*, **R. Grunhut** blamed the proportions of chimneys, which were due to obsolete building laws. **W. Reid** referred to the bye-laws in France and Germany, and to the importance of producer gas. **W. M. Mordey** pointed out that the variations in load conditions made the work in electric stations difficult, but supported the use of gas for economy and smokelessness. **H. A. Des Voeux** gave particulars of the Coal Smoke Abatement Society of London, and of their work of giving technical instruction to stokers. **Owens** stated that the loss in solid carbon, tar, and unburnt hydrocarbons in domestic chimneys approached 5 per cent. of the total weight of fuel burned, and inquired if there were any similar data for factory chimneys. In reply, the **Author** stated that with black smoke the heat lost amounted to about 30 or 40 per cent. of the heat value of the fuel, in consequence of bad conditions of combustion. [See Abstracts Nos. 15 (1905), 691 (1906).] F. J. R.

358. *The Testing of Coal.* **A. Bement.** (West. Soc. Engin., Journ. 11. pp. 758–761; Discussion, pp. 761–792, Dec., 1906.)—The author discussed the usual method of carrying out and stating the results of the analysis of coal, and gave reasons for the abandonment of the tests for moisture, volatile matter, fixed carbon, sulphur, and evaporative power. For these tests he would substitute the following: Ash in dry fuel, Size of the coal, Heating power of the pure coal. The *moisture* test: Each seam of coal had a standard percentage of moisture as mined, and this should be fixed once for all by official tests; but tests of the moisture in the coal as delivered would give quite other results, and were not worth the trouble entailed. The modification introduced by Parr and the State Geological Survey Dept. of estimating the moisture lost by the sample during air-drying was of little importance, for here again the conditions which determined the result were variable. The *volatile matter* test was one which varied as carried out by different observers, and since the conditions under which it was carried out could not well be standardised, it might well be dispensed with. The test for *fixed carbon* being carried out at the same time as the volatile matter test, was open to the same objections, and should likewise be discarded. As regards *evaporative power*, or the practical steam-raising test, this depended upon so many factors that, as a test of the actual heat value of the fuel, it was absolutely worthless. Its only value, in fact, was as a means of determining which size of any selected fuel gave the best results under the normal conditions of working. All information of practical value relating to coal for steam-raising purposes could be obtained from the *Ash* and *Calorimeter* tests, in conjunction with a test for determining the average size of the coal. The ash and calorimeter tests should be carried out on the dry fuel, and the result of the calorimetric test should be expressed in relation to the *pure coal* contained in the sample, this term being used in place of *combustible*, which has been used previously to denote the same thing, namely, the combustible matter of the fuel plus the chemically-combined nitrogen and water. The *pure coal* then represents what remains after deducting the moisture and ash from the sample as prepared for testing; and it will be found that, for the coal of any one district, the calorific value worked out upon *pure coal* shows

little variation. *Discussion:* **Parr** gave his reasons for using air-dried coal for testing purposes, namely, that it neither lost nor absorbed moisture during the laboratory operations; and also urged the value of the ratio of volatile carbon to fixed carbon for practical engineers. **Breckenridge** stated that the paper ought to have been entitled, "Characteristic Properties of Coal of Importance to the Consumer," since this was its subject. He agreed with the author on the subject of *evaporative power* tests, but while agreeing that the results of these tests should not be used in the specification under which the fuel was bought, he considered that, when carefully carried out, the practical steam-raising tests gave much information of value to the boiler engineer. **G. S. Rice** referred to the ash tests, and to the fact that coal from the same seam may show varying percentages of ash, according to the nature of the strata above and below it, and to the care used in picking or washing it. **P. C. McArdle** gave details of the methods used by the city of Chicago in coal purchase, and stated that, as carried out by them, the practical steam-raising tests under the boilers agreed closely with the results of the calorific determinations made in the laboratory. J. B. C. K.

359. *Determination of Calorific Value of Coals.* **E. J. Constam** and **R. Rougeot.** (Zeitschr. Angew. Chemie, 19. pp. 1796–1806, 1906.)—The authors have carried out a large number of calorific determinations of various classes of coal with the Parr calorimeter and with the Mahler bomb. They find that with the former the number of calories corresponding to 1° C. rise in temperature varies with the purity and coarseness of grain of the sodium peroxide used, and that the variation due to these causes may amount to 8 per cent. of the total. The closest agreement between the results from the two forms of calorimeter was obtained when using an excess of finely-powdered sodium peroxide mixed with potassium persulphate in the Parr apparatus. The authors state, however, that in no case have they obtained complete combustion of the fuel in the Parr calorimeter, and consequently they do not recommend its use for determinations of calorific value of any importance.

J. B. C. K.

360. *Calculation of Calorific Value of Coal by Goutal's Formula.* (Journ. f. Gasbeleuchtung, 48. p. 1007, 1905. Stahl u. Eisen, 27. p. 272, Feb. 20, 1907.) —A discussion of the use and value of Goutal's formula for calculating the calorific value of fuel from the results of the approximate analysis [see Abstract No. 252 (1908)]. The following example is given to show the closeness of the calculated and observed results: *Approximate analysis of fuel.*—Fixed carbon, 86·70 per cent.; volatile matter, 10·05 per cent.; ash, 1·45 per cent.; moisture, 1·80 per cent.; calculated value from above test, 8,406 calories; observed value by use of Mahler bomb, 8,404 calories. The results of the calculated value are usually within 1 per cent. of the observed, but anthracite and lignite give calorific values by the Goutal formula, showing a larger margin of error. J. B. C. K.

361. *Method and Apparatus for Testing Waste Furnace Gases.* (Brit. Pat. 22,919 of 1905. Soc. Chem. Ind., Journ. 25. pp. 1210–1211, Dec. 31, 1906. Abstract.)—This instrument and method, patented by the Cambridge Scientific Instrument Co. and C. V. Burton, depends upon the variations in pressure of the waste gases when confined in a closed vessel, having porous walls or a porous partition. Under such conditions the air from outside diffuses into

the vessel more rapidly than the waste furnace gases diffuse outwards, and a rise of pressure occurs within the vessel, as in the well-known fire-damp detecting apparatus. This increase of pressure is regulated by the difference in specific gravity of the waste gases and the outside air, and the method is thus applicable to the determination of the proportion of CO_2 in furnace gases. The details of the apparatus cannot be understood without the accompanying diagram; but it is automatic in action, and can be provided with a recording attachment for registering the results. J. B. C. K.

362. *Water-softening.* **G. C. Whipple.** (Cassier, 31. pp. 416–436, March, 1907.)—The author discusses the advantages of water-softening to householders and manufacturers, and then describes the principles of the methods in use and the types of apparatus employed. Discussing the question of boiler corrosion, he states that sodium chloride in presence of silica is corrosive, and that waters which naturally are non-corrosive may become so on concentration. As regards boiler compositions, he asserts that when necessary they can be made much more cheaply than bought, a saving of 35 to 85 cents per gall. being possible in this matter. Discussing combined feed-water heaters and purifiers, he considers that it is preferable to carry on separately the operations of softening and heating. The most accurate figures relating to the economy of water-softening are those published by the American railroad companies. In the case of the Chicago and North-Western Railroad, a comparison of the results obtained for two years at 17 stations show a saving of $75,000 on engine maintenance and repairs, due to the use of softened water. J. B. C. K.

GAS AND OIL ENGINES.

363. *The Tuscany Suffioni as a Source of Power.* **P. Ginori-Conti.** (Elettricista, Rome, 6. pp. 68–74, March 1, 1907.)—The author has measured the temperature and pressure of, and power to be derived from, three of the most important suffioni in Larderello, obtaining the following results:—

Name of Suffioni.	Pressure in Atmos.		Temperature, ° C.		Velocity, Metres per Sec.	Weight of Gas Evolved in Kg. per Sec.	Theoretical Power in H.P.
	Closed.	Open.	Closed.	Open.			
Foro di Piazza Anna	3⅘	3	157·5°	165°	172	8	2,334
Foro della Venella ...	5⅘	4	142°	150°	106	8·89	1,263
Foro Forte	3½	2½	148°	162°	106	2·32	336

The corrosive action of the vapours upon metals has been overcome, and a motor of some 35–40 h.p. has been worked by suffioni energy since May, 1905, with highly satisfactory results. W. H. Sl.

364. *Körting Gas Engines at Shelton Iron Works.* (Engineering, 83. pp. 204–206, Feb. 15, 1907.)—The two double-acting gas engines here illustrated are designed to develop 400 i.h.p., and on overload 600 i.h.p. with coke-oven gas. The speed is 107 r.p.m., and each is direct coupled to a 225-kw. 500-volt

continuous-current generator, the two cylinders being placed side by side in the engine-room, so that the gas main runs across the centre of the engine-room below the cylinders, and the flywheels and dynamos are at opposite ends of the engine-room. The arrangement economises space. The gas first used had a varying calorific value of from 450 to 850 B.Th.U. per cub. ft. at beginning and end of the coking process, and the compression adopted in the engine was 100 lbs. per sq. in. Ignition was by magnetos operated by eccentrics mounted on the cam-shafts—two magnetos being arranged to work four sparking plugs—two at each end of the cylinder independently. Recently gas averaging 881 B.Th.U. per cub. ft., and containing CO, 8·55; olefines, &c., 5·18; O, 1·59; methane, 27·82; H, 54·88; and N, 8·16 per cent. has been employed, from which the engines at full load develop 1 h.p. with 22 cub. ft. of gas. The engines have been at work now for over 12 months satisfactorily, supplying current to motors distributed about the works, about 200 h.p. being absorbed in coal-washing plant. The engines are governed by throttling the gas supply to the pumps. F. J. R.

365. *Gas Engines.* (Engineering, 83. p. 33, Jan. 4, 1907.)—This is an abstract of W. V. Oechelhaeuser's specification of a British Patent (No. 1,575 of 1906) for a vertical arrangement of this design of gas engine, in which the essential feature consists in employing a hollow supporting frame, these hollow standards being used as passages for the gases and air, and for exhaust. Between the cylinder and these standards or columns there is a head-piece with an annular chamber which communicates with the exhaust ports and with the larger column, a partition in this chamber forming other compartments for the scavenging air and mixture of gas and air, which communicate by means of pipes with thin slot ports and with the smaller columns. F. J. R.

366. *Elimination of Carbon Dioxide from Exhaust Gases of Gas Engines* (Brit. Pat. 3,570 of 1906.)—This patent of P. Winand, for removal of CO_2 from the exhaust gases of internal combustion engines, such as are used in submarines, is based upon the addition to the gases of a compound capable of combining with the CO_2, either before or during combustion. If a volatile gas, such as ammonia, be employed, it may be evaporated under pressure, and made to perform useful work in the engine. Another salt which may be used is sodium nitrate; this may be heated to yield oxygen and sodium hydroxide. The oxygen is employed to support the combustion process, and the base to absorb the CO_2 produced. A third class of compounds which may be employed for the purpose are the alkaline peroxides, the action in this case being similar to that described in the case of sodium nitrate. J. B. C. K.

AUTOMOBILISM.[1]

367. *Gas Turbine for Automobile Propulsion.* **W. H. Stuart-Garnett.** (Cassier, 31. pp. 410–415, March, 1907.)—The difficulty of applying condensing apparatus to a motor car or locomotive stands in the way of the applicability of the steam turbine to these vehicles. The gas turbine might, however, be applied either to direct driving or to a dynamo, which would supply electricity to a motor, giving great elasticity in the relation between the speed of turbine

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

and that of the car. The paper reviews the difficulties in the way of a successful internal combustion turbine, and advocates direct injection of water (previously heated by the exhaust gases) into the ignited gases before they act on the turbine blades or buckets. The drop in temperature and volume of the gas thus occasioned will be compensated to some extent by the addition of the superheated steam formed to the working fluid and its thereby increased density. As a higher degree of compression is required for the constant-pressure combustion engine than for the Otto cycle, the writer advocates the use of the latter for the gas turbine, where the gases should be exploded in a closed chamber and the highly compressed resulting mixture applied to different stages of the turbine according to its pressure, *i.e.*, to one stage after another in succession as the pressure falls. For small motors the use of liquid air or oxygen under high pressure is advocated, this liquid being admitted through a throttle into an evaporator, where it would be heated or even superheated by the exhaust gases, and then mixed with the combustible also admitted under pressure. F. J. R.

368. *The B.T.H. Petrol-Electric System.* (Elect. Engin. 39. pp. 333–335, March 8, 1907.)—In this system the transmission is entirely electrical. The petrol engine drives a dynamo of special design, whose characteristic is such that the product of volts and amperes remains practically constant. Hence the engine is kept running fully loaded irrespective of the fluctuations in the current. The power is transmitted to two motors, each of which drives a road wheel independently, the differential gear being eliminated. The dynamo is designed to be coupled to a 30–40-h.p. engine; it is rated at 15 kw., 850 r.p.m., 130–65 volts, but is capable of withstanding heavy temporary overloads. Each motor is rated at 7·5 kw., 130–65 volts, 1,400–500 r.p.m. The motors are series wound, and series-parallel control is used. The controller provides the following motor connections: (1) Speed forward, motors in series; (2) speed forward, motors in parallel; (3) "off" position; (4) reverse, motors in series. The advantages claimed for the system are noiselessness of operation, simplicity of control, and efficiency. A. H.

REFERENCES.

369. *Comparison of Melms-Pfenninger and Parsons Steam Turbines.* F. Marguerre, M. Schröter. (Zeitschr. Vereines Deutsch. Ing. 51. pp. 344–346, March 2, 1907.)—This paper gives a description of tests carried out on a 500-kw. turbine built by Melms and Pfenninger. Research on the same turbine has previously been described [Abstract No. 104 (1907)], and the turbine is here compared with a 600-kw. Parsons turbine and a pressure-excess turbine by Brown, Boveri and Co. Numerous tables and diagrams are given. A. W.

370. *Flow of Steam in Steam Engines.* O. Schneider, W. Schüle. (Zeitschr. Vereines Deutsch. Ing. 51. pp. 227–229, Feb. 9, 1907.)—In the first part of this paper Schneider gives a method for the construction of the stream lines from the indicator diagram, and discusses the flow with various types of governing. In the latter part Schüle criticises and discusses Schneider's results and gives further theory. [See also Abstract No. 259 (1907).] A. W.

371. *Tani's Aeroplane Model.* (Automotor Journ. 12. pp. 208–210, Feb. 16, 1907.) —Illustrated. Comprises some special mechanical features.

INDUSTRIAL ELECTRO-CHEMISTRY, GENERAL ELECTRICAL ENGINEERING, AND PROPERTIES AND TREATMENT OF MATERIALS.

372. *McDonald Electrolytic Bleach and Caustic Plant at Johnsonburg.* **J. R. Crocker.** (Electrochem. Ind., N.Y. 5. pp. 43–44, Feb., 1907.)—The McDonald cell has been installed in the paper-mill of the New York and Pennsylvania Co. at Johnsonburg, Pa., and has been in operation for one year, the plant having a capacity of 16 tons of bleaching powder and 6½ tons of caustic soda per day. The generating plant is steam driven, each 750-h.p. unit supplying 2,000 amps. at from 180 to 270 volts. The cells are located in the second and third floors of the factory, the first containing 250 cells and the second 350 cells. They are connected in series of 50 to the switchboard, each set of 50 cells being supplied with current from one generating unit. On the ground floor of the factory the bleaching liquor tanks are placed; these have an aggregate capacity of 72,000 galls. The solution of salt is supplied to the cells automatically—from large storage vats placed on this same floor. The chlorine gas from the anode compartments of the cells is led through chlorination towers placed upon the second floor, and is here absorbed in milk of lime. This bleaching solution is then delivered at its point of consumption by aid of a system of piping and of rotary pumps. The caustic soda leaves the cell at a density of 15° Bé. and is delivered to an Ordway evaporator. This apparatus concentrates the solution up to 45° Bé. and removes the salt. The repairs of the plant have been abnormally low, and the cells after 8 months' work only required new anodes. J. B. C. K.

373. *The Hermite Electrolytic Process at Poplar.* **C. V. Biggs.** (Faraday Soc., Trans. 2. pp. 182–191; Discussion, pp. 191–198, Feb., 1907. Electrician, 58. pp. 205–206; Discussion, pp. 206–207, Nov. 23, 1906. Abstract.)—The process employed [see Abstracts Nos. 1520 (1905) and 1086 (1906)] is described. In the *discussion*, **F. W. Alexander**, the Medical Officer of Health to whom the plant is due, gave information as to the cost, and recommended the hypochlorite for its purpose. **J. B. C. Kershaw** criticised the paper and the Hermite process, which could not compete with bleach; while **S. Rideal** considered that the convenience of easy local disinfection and of watering the roads with hypochlorite justified such plants. H. B.

374. *Depreciation of Electrolytically-produced Solutions of Sodium Hypochlorite.* **W. P. Digby.** (Faraday Soc., Trans. 2. pp. 165–180; Discussion, pp. 180–181, Feb., 1907. Eng. Rev. 14. pp. 85–89, Jan., 1906.)—Having shown that hypochlorite may revert to chloride during the process of manufacture, the author examines the depreciation of electrolytic hypochlorite when stored. Solutions containing 4·145 gm. of available chlorine per litre contained after 1,187 days when kept in dark amber-coloured bottles 1·918, in medium amber bottles 1·878, in white glass bottles 0·354, in dark blue glass bottles 0·425 gm. per litre. In 1,317 days a solution kept in dark amber glass lost 40 per cent. of its chlorine. Of single metals, iron and tin decompose

the hypochlorite most rapidly; graphite has no effect. Of metal couples—which can be recommended for constancy tests—those in which iron is the one element deteriorate the hypochlorite most rapidly; tinned plate and zinc couples are also bad; couples of ebonite and a metal are far worse than the single metal—possibly owing to the sulphur in the ebonite, **H. Borns** suggested in the *discussion*. The greater the metallic area the more rapid the depreciation. Insulating paints for metallic vessels cannot much be relied upon. H. B.

375. *Electrolytic Refining of Metals (Copper).* (U.S. Pat. 842,254. Electrochem. Ind., N.Y. 5. p. 103, March, 1907. Abstract.)—A. Schwarz compresses concentrates, *e.g.*, of chalcopyrite without smelting into matte, into anode cubes held by frames as in storage batteries. The tanks are charged with sulphuric acid and copper sulphate; the copper is to be deposited by currents of from 3 to 5 amps./sq. ft., and the dissolved iron and the sulphuric are then to be recovered, the former as oxide. Treatment of the slimes is also proposed. H. B.

376. *Combustion of Nitrogen in the Electric Arc.* **F. Russ.** (Elektrotechnik u. Maschinenbau, 25. pp. 245–246, March 24, 1907. From paper read before the Ingenieur-u. Architekten-Verein, Wien, March 11, 1907.)—References to the scientific and technical problems, to Mond-gas, Frank and Caro, Birkeland and Eyde, and others. According to Nernst, half of the possible NO could be formed in air, at atmospheric pressure, at 1,000° C. abs. in 81·6 years, at 1,500° in 1·2 days, at 1,900° in 2·1 min., at 2,100° in 5 sec., at 2,900° in $3·4 \times 10^{-5}$ sec. According to Jellinek, half of the pure NO formed would be decomposed again: at 900° C. in 8·1 days, at 1,500° in 3·8 min., at 1,900° in $2·9 \times 10^{-4}$ sec., at 2,100° C. in 2×10^{-5} sec. The author and Grau have determined the energy relations and yield of the NO formation with vertically arranged electrodes. The yield is, on the whole, better with longer than with shorter arc flames; the kw.-year can yield 454 kg. of nitric acid (concentration not indicated) with arcs of 3 cm. and 550 kg. with arcs of 5 cm. length. The Badische Anilin- und Sodafabrik uses very long arcs (8 m.) in glass tubes with vertical electrodes at comparatively low potential. H. B.

377. *Calcium Carbide Manufacture.* (U.S. Pat. 844,018. Electrochem. Ind., N.Y. 5. pp. 102–103, March, 1907. Abstract.)—H. L. Hartenstein makes calcium carbide direct from marl. The marl, which contains from 20 to 50 per cent. of water, is dried, crushed, powdered, and calcined in rotary furnaces at 3,000° F.; a certain amount of moisture is favourable for the calcination, and the disintegration of the marl may be accelerated by passing dry air mixed with steam into the furnace. The calcined material—essentially lime, with a small percentage of silica, magnesia, and alumina—is in the hot state mixed with coke, which has been preheated by the waste gases from the calcining furnace, and run into the electric carbide furnace. H. B.

378. *Electric Zinc Furnace.* (U.S. Pats. 843,776, 843,777. Electrochem. Ind., N.Y. 5. p. 103, March, 1907. Abstracts.)—E. R. Taylor distils zinc ores in a shaft furnace. In the circular hearth 4 carbon electrodes, protected by firebrick walls, are arranged radially around a space into which granular coke

is fed through lateral inclined pipes. Above this space is the mouth of a large hood, and the mixture of zinc ore and coal glides down in the annular space between the outer wall of the hood and the furnace wall. Down below the mixture is kept agitated by screws mounted in two rings, the one above the other. The heavy vapours are drawn off, through tubes whose orifices lie below the mouth of the bell, into a condenser; the lighter gases pass up the hood and escape laterally. H. B.

379. *Special Tariff Meter.* **G. B. Picecco.** (Elettricità, Milan, 28. pp. 34–36, Jan. 18, 1907.)—This meter has been made by the Siemens-Schuckert Werke for use with a tariff somewhat extensively adopted for motor supply in Italy. A fixed annual charge is made for all energy supplied so long as the power at any moment does not exceed a certain value. If the power exceeds this value the excess is charged for at a rate per kw.-hour. The spindle of an ordinary meter is connected through differential gear to a clock, and the differential spindle—rotating one way if the power exceed the value for which the gearing is designed and the other way if the power be less—is connected by a ratchet wheel to a counting train, so that the latter only runs when the power exceeds the limit. A. E. L.

380. *Siemens and Halske Wattmeters.* **H. Sack.** (Elektrotechn. Zeitschr. 28. pp. 268–271, March 21, 1907.)—In the first part of the paper an illustrated description is given of the new type of three-phase wattmeter introduced by the Siemens and Halske A.-G. The two rectangular pressure coils are mechanically connected by a thin brass tube. The upper horizontal part of the top coil and the lower horizontal part of the bottom coil are provided with inwardly projecting steel pivots which fit into jewelled bearings, there being no continuous spindle running through the two coils from top to bottom; owing to the absence of such a spindle, the movable system is highly elastic and the instrument readily portable. For purely mechanical reasons, it is desirable to make the distance apart of the movable coils as small as possible, and this necessitates placing the current coils in close proximity to each other. Since each pressure coil will now be affected by the magnetic field of *each* current coil, the ordinary 2-wattmeter arrangement of connections cannot be used, and the method adopted—due to A. Franke—is as follows. The current coils are placed in two of the mains. The two pressure coils are connected to a common point, and between this and the main not containing any current coil, a non-inductive resistance is connected. The remaining ends of the pressure coils are joined in series with non-inductive resistances, and are connected to the mains containing the current coils. It is shown that by giving the non-inductive resistances suitable values the wattmeter may be made to read correctly. The second part of the paper describes recent improvements in the single-phase precision wattmeter. The instruments described are all provided with air damping. A. H.

381. *Magnetic Shunt for Motor Meters.* (Brit. Pat. No. 1,115 of 1906. Engineering, 83. p. 403, March 22, 1907. Abstract.)—In order to secure accuracy in motor meters employing permanent magnets, the British Thomson-Houston Co., Ltd., and A. J. Martin have devised a soft-iron magnetic shunt placed across the poles of the permanent magnet and surrounded by a compensating coil which is either in parallel with the armature or in the main circuit. The characteristic feature of the invention

is the design of the shunt so as to secure *saturation* beyond a certain load, so that the shunt produces no appreciable variation in the flux beyond a certain speed, and only exerts its regulating action at lower speeds. A. H.

382. *Temperature-coefficient for Copper.* F. B. Crocker. (Electrical World, 49. pp. 385–386, Feb. 23, 1907. Electrician, 58. pp. 968–969, April 5, 1907. Abstract. Écl. Électr. 51. pp. 63–65, April 13, 1907.)—In a short article the author criticises certain of the formulæ that have been adopted as representing the change of resistivity with temperature. Matthiessen's original parabolic equation is shown to lead to incorrect results, and a table is drawn up to indicate the magnitude of the errors corresponding to five formulæ that are assumed to be in common use. [The author has overlooked the important work of Clark, Forde, and Taylor, who investigated this matter, and who provided coefficients and tables applicable to modern electrolytic copper wire. A summary of their results was given in the article dealt with in Abstract No. 1170 (1899).] R. A.

383. *New Method of Fastening Insulators.* C. Egnér. (Electrician, 58. pp. 804–805, March 8, 1907. Translated from the "Teknisk Tidskrift." Elektrotechnik u. Maschinenbau, 25. p. 228, March 17, 1907.)—In the method described, special insulating caps, consisting of extra strong paper impregnated with insulating material, are interposed between the insulator and its support, instead of black oakum. The crinkled caps are pressed over the support by hand, a suitable number—depending on the type of insulator—being used, and the insulator is then screwed on over the caps. The advantage claimed is a much higher insulation resistance than that obtainable with oakum. A. H.

384. *Electric Driving of Printing Presses.* M. Arbeiter. (Elektrotechn. Zeitschr. 28. pp. 260–263, March 21, 1907.)—The author critically examines the various systems available, including three-phase as well as continuous-current ones, and arrives at the conclusion that even where it is necessary to transform from three-phase to continuous current, the latter is more economical. The most satisfactory method of speed control is that in which two voltages of supply, one being double the other, are available. Thus, taking the case of a 2 × 110-volt three-wire system, the controlling switch would be designed to perform the following series of operations. At starting, the motor field is connected across the 220-volt mains, and its armature, in series with a suitable resistance, across the 110-volt mains. By cutting out the resistance, the speed may be increased up to a certain limit. The speed is next doubled by gradually weakening the field. The field rheostat is then short-circuited, the armature circuit opened, and transferred to the 220-volt mains. A further increase of speed is then obtainable by again weakening the field. A. H.

385. *150-ton Giant Electric Crane.* (Engineer, 103. pp. 118–120, Feb. 1, 1907.)—The article contains a description of a 150-ton crane built by the Glasgow Electric Crane and Hoist Co., Ltd., for MacColl and Pollock, Ltd., of Sunderland. The difference in the British and the German design of large cranes is gone fully into. In the British design the whole weight of the structure is carried by the four legs of the tower and the stresses on the foundations, apart from those due to horizontal wind forces, are all vertical. The German cranes all have a tower about which a T-shaped structure

revolves. This construction not only involves a considerably greater amount of structural work, entailing greater expense and greater deflection when loaded, but the stresses on the foundations are also greater. In the German design, owing to the slanting standards, a large amount of scaffolding is involved in erection, while in the British practically no scaffolding at all is required. W. J. C.

REFERENCES.

386. *Size of a Battery for a given Capacity at a Variable Discharge Rate.* **P. Faure-Munro.** (Ind. Elect. 15. pp. 447-448, Oct. 10, 1906.)—The author gives a graphic method which can be employed for finding the number of plates per cell required. The method is based upon the employment of Peukert's equation $C^nT = K = a$ const., where C is the current at constant intensity and T the duration of discharge. K is constant for a given type of cell, but varies for different types. For the best-known makes of cell n varies between 1·3 and 1·4. An example is worked out. L. H. W.

387. *Glass Production in the Electric Furnace.* **J. Escard.** (Houille Blanche, 6. pp. 1-6, Jan., and pp. 28-35, Feb., 1907.)—The different types of electric furnace designed for this purpose are described, with illustrations.

388. *Extraction of Metallic Sodium.* **C. F. Carrier, Jr.** (Electrochem. Ind., N.Y. 4. pp. 442-446, Nov., and pp. 475-480, Dec., 1906.)—Collected references to the literature and a brief discussion of the different processes with special reference to electrochemical production on a large scale.

389. *Graphical Representation of Quantity and Energy in Alternating-current Circuits.* **J. Kuhn.** (Elektrotechn. Zeitschr. 28. pp. 217-218, March 7, 1907.)—The author shows that if the p.d. and current obey the simple harmonic law, the quantity and energy supplied during any time-interval may be represented by areas bounded by circular arcs and straight lines. A. H.

390. *Graphical Method of determining Power from P.D. and Current Waves.* **M. Jakob.** (Elektrotechn. Zeitschr. 28. p. 243, March 14, 1907.)—The method described depends on the determination of the area of a polar curve plotted with phase angle as the vectorial angle and the algebraical sum of instantaneous p.d. and current as radius vector. A. H.

391. *Leakage Indicator.* (Brit. Pat. 27,271 of 1906. Engineering, 83. p. 403, March 22, 1907. Abstract.)—J. M. Moffat, R. J. Bott, J. W. Manley, and the Electric Safety Appliances Co., Ltd., have patented a method of winding a differential leakage indicator which consists in twisting the two conductors together to form a cable which is used in winding the coil of the instrument, exact differential action being thereby secured. A. H.

392. *Calculation of Electromagnet Coils.* **R. Edler.** (Elektrotechnik u. Maschinenbau, 25. pp. 155-157, Feb. 24, 1907.)—A supplementary numerical example is worked out which presents more complications than those previously dealt with by the author [Abstract No. 41 (1907)]. A. H.

GENERATORS, MOTORS, AND TRANSFORMERS.

393. *Testing of Large Motors and Generators.* **C. J. Fay, H. L. Beach.** (Elect. Journ. 3. pp. 475–477, Aug.; 525–530, Sept.; 653–656, Nov.; and pp. 702–709, Dec., 1906. Elect. Engin. 38. pp. 580–581, Oct. 26, 1906. Abstract.)—The following method of testing large series-wound railway motors is advocated by Fay. The two motors to be tested are coupled mechanically, and one of them, which is to run as a motor, is connected directly across the supply mains. The other machine, which is to be used as a generator, has its armature connected on one side to one of the mains. The junction of its field and armature is connected to the armature of a separately excited booster, this armature being on the remaining side connected to the other main Thus the generator and booster armatures are connected in series with each other and then across the mains. The field of the generator is connected in series with an adjustable resistance and then across the brushes of the booster. The resistance in the generator field is adjusted so as not to over-excite the field at the rated load of the machine, and generally remains unaltered at this value throughout the test. Ordinary changes of load are effected by controlling the booster field. An interesting method of testing railway motors for temperature-rise, &c., under conditions closely resembling those which prevail in ordinary practice is described by Beach. The method is used by the (Westinghouse) Electric Co., and involves the use of one or two heavy flywheels mounted on a shaft which is coupled to the motor. This shaft is also fitted with large pneumatically controlled Prony brakes. A cycle of operations is decided upon, resembling, as nearly as possible, the series of operations characteristic of a typical run on the actual line for which the motor is intended. This cycle consists of starting and accelerating at approximately constant current, running for a time, switching off, applying brakes, and stopping for a short period. The cycle is arranged to be performed automatically by a controller having suitably arranged contacts, and driven at the required speed by a small auxiliary motor. The testing thereby becomes entirely automatic. A. H.

394. *New Method of Compounding Alternators.* **E. Roth.** (Écl. Électr. 48. pp. 241–252, Aug. 18, 1906.)—The alternators are compounded by means of two directly coupled rotary converters. In a three-phase machine the alternating-current terminals of one of the rotaries are connected with the secondary terminals of a three-phase transformer, the primary terminals of which are connected with the terminals of the alternator. The other rotary is connected with a second transformer the primary coils of which are in series with the load on the alternator. On the direct-current side the rotaries are connected in series and supply the current for their own field coils and also for the field coils of the alternator. A complete theory is given of the action of the compounded machine, and it is shown that the sum of the two direct e.m.f.'s generated follows the exact law necessary for compounding. This method has been tested in the workshops of the Société Alsacienne de Constructions Mécaniques. The results of the tests will be given in a future paper. A. R.

395. *Alternator Construction, Testing, and Operation.* **P. M. Lincoln.** (Elect. Journ. 3. pp. 545–558, Oct.; 631–641, Nov.; and pp. 668–681, Dec., 1906.)—These articles contain a series of notes on details of construction, methods of testing, and operation of alternators. The yoke ring is a single casting up to a diam. of about 8 ft.; beyond this, it is split. The almost universal practice is to make the bed-plate, the bearing pedestals, and the yoke ring all separate castings, which are machined and bolted together. The standard windings of modern alternators are for 220, 440, 1,100, 2,200, 6,600, 11,000, and 13,200 volts, and the standard frequencies are 25 and 60. The compound winding is only used in the case of machines below 200 kw., as above this output the commutating difficulty becomes serious. The following is a commonly accepted standard as regards temperature-rise for alternators whose voltage is 2,200 or less, the temperature being measured by thermometer: Full load run for 24 hours, temp.-rise not to exceed 40° C.; 25 per cent. overload for 24 hours, temp.-rise not to exceed 50° C.; 50 per cent. overload for 1 hour, temp.-rise not to exceed 60° C. The amplitude of the oscillations caused by the varying torque of the prime mover should not exceed $\frac{1}{30}$th of the pole-pitch. A. H.

396. *Heating of Armatures and Field Coils.* **L. Ott.** (Mitteil. über Forschungsarbeiten des Vereines Deutscher Ingenieure, No. 35 and 36. pp. 58–107, 1906. Electrician, 58. pp. 805–807, March 8, 1907. Abstract. Communication from the Laborat. f. techn. Physik der kgl. techn. Hochschule, München.)—The experiments described were undertaken for the purpose of determining (1) the interior thermal conductivity of a laminated core (*a*) across and (*b*) along the laminations; and (2) the exterior conductivity of the surface when exposed to (*a*) still and (*b*) moving air. The method for obtaining (1) was a direct one, the flux of heat being measured by the temperature-rise of a constant current of water passing through a calorimetric cylinder applied to the cold end of the laminated mass under investigation, and the temperature gradient being determined by a series of thermo-junctions of steel and constantan. The hot end of the laminated mass was applied to a cylinder containing water heated electrically. For the two samples of stampings tested, the values found for the conductivity across the laminations (with thin paper as insulating material) were 0·0025 and 0·0018 gramme-calorie per cm. per sec. per degree C. The conductivity parallel to the laminations was found to be 0·1865, in terms of the same unit. The exterior conductivity of a bare or thinly varnished surface was found to be $0{\cdot}0038\ (1 + 0{\cdot}25\,v)$ watts per sq. cm. per degree excess of temperature, v denoting the air velocity in metres/sec., while in the case of a heavily varnished surface the value was $0{\cdot}0030\ (1 + 0{\cdot}107\,v)$. Formulæ are established for the temperature-rise in armatures and field coils, and tables of the constants are given which occur in the formulæ. The connection between the mean and maximum temperature-rise in field coils is investigated. A. H.

397. *Calculation of Reversing-pole Windings.* **A. Keller.** (Electrical World, 49. pp. 508–511, March 9, 1907.)—The author establishes formulæ for the magnetic reluctances of the flux paths around the short-circuited coil, and from these calculates the e.m.f. induced in the coil by the current reversal. The induction under the reversing pole-shoe required to induce an e.m.f. of the same magnitude is then determined, and from this the total ampere-turns necessary on each reversing pole are calculated. The author suggests

slotting the reversing pole down its middle, as this will have the effect of reducing the reactance voltage without necessitating any increase in the amount of copper on the reversing pole. A. H.

398. *Brush-contact Drop.* **E. Arnold** and **E. Pfiffner.** (Elektrotechn. Zeitschr. 28. pp. 263–267, March 21, 1907.)—The present investigation had for its object the determination of the relation connecting the voltage drop over a brush contact with temperature, the current density over the contact area being maintained constant at all temperatures. The apparatus employed consisted of a bronze slip-ring whose temperature could be varied at will by adjusting the current flowing in a special heating coil arranged immediately underneath the slip-ring. This heating coil, which was built into the drum supporting the slip-ring, consisted of a strip of nickelin insulated with asbestos, and by means of it the temperature of the slip-ring could be raised up to 100° C. Current was supplied to the heating coil by means of two small supplementary slip-rings. The temperature of the slip-ring was accurately measured by a copper-resistance thermometer consisting of two insulated coils of 0·2 mm. copper wire applied to the flanks of the slip-ring. The peripheral velocity was 7·4m./sec., and the pressure 160 gm./cm.^{2}, throughout the experiments; and in order to obtain reliable results each brush was in use for several days before any readings were taken. It was found that temperature exerted a very marked effect on the contact drop, the drop decreasing considerably (in some cases to only a small fraction—one-fifth and less—of its original value) with rise in temperature; although in some cases a slight initial rise was detected, followed by a drop. A very marked difference was clearly established between the behaviour of a positive and that of a negative brush as regards the effect of temperature. As a general rule, at the lower temperatures the negative brush gave a higher drop, but with increasing temperature the drop at the negative brush decreased at a much more rapid rate, finally falling to a value greatly below the drop at the positive brush. The above results show that in the testing of brush carbons it is very important to investigate the effect of temperature. An excessive decrease in the contact drop with rise in temperature may give rise to sparking, and the known fact that sometimes machines capable of running sparklessly when cool begin to give trouble with increasing temperature receives a ready explanation. The fact that carbon brushes have been found unsatisfactory at high peripheral speeds is largely due to the excessive temperature-rise brought about by friction. Thorough ventilation of the commutator and brushes in the case of turbo-generators furnishes an excellent means of improving the commutation. Where the commutation difficulties are great, it is advisable to use different brands of carbon for the positive and negative brushes. It is desirable that a brand of carbon should be produced which will withstand temperatures up to 80° or 100° C. without exhibiting any large decrease in the contact drop. A. H.

399. *Advantages of Commutating Poles for Railway Motors.* **C. A. Mudge.** (Electrical World, 49. pp. 505–506, March 9, 1907.)—The author discusses the improvements in the design of railway motors which are rendered possible by the use of commutating poles. Among these are an increase in the amount of armature copper, a reduction of the air-gap, a shortening of the commutator and lengthening of the armature core, and an increase in the length of the polar arc. The width of the commutating pole-shoe should be from 1¼ to 1½ times the tooth-pitch. The number of segments in

the commutator should not be reduced too much, as this may, owing to armature distortion, concentrate a voltage exceeding the safe limit on the few coils in the stronger part of the field, and cause flashing over. One very great advantage resulting from the use of inter-poles is the possibility of using field control for speed regulation, and thereby greatly reducing the losses during the acceleration period. A. H.

400. *Danger Connected with Variable-speed Inter-pole Motors.* **W. Oelschläger.** (Elektrotechn. Zeitschr. 28. pp. 211–218, March 7, 1907. Electrical World, 49. pp. 644–645, March 30, 1907. Electrician, 59. p. 24, April 19, 1907.)—All commutator troubles in continuous-current machines may be traced either to excessive reactance voltage or to excessive voltage between neighbouring commutator segments. The latter may cause the machine to flash over. This trouble as a rule never arises in the case of ordinary machines, as the reactance voltage is generally chosen so small that the voltage between segments is always well below the limit of safety. But in the case of shunt-wound motors, with forced commutation, designed for speed control between very wide limits by the shunt rheostat method, the effect of armature distortion becomes so great at the higher speeds—when the main field is very weak—that reversal of the flux occurs over a considerable area of each pole-shoe, and as a result the counter-e.m.f. of the motor may rise to values considerably in excess of the brush p.d., since to this latter is added the e.m.f. induced in the coils moving across the reversed part of the field. Values of the voltage between segments may then be obtained, which will cause the machine to flash over, in spite of the fact that the running may be quite sparkless up to the dangerous limit of speed. In illustration of this fact the author describes the results of some tests of a 21-h.p., 520-volt, inter-pole motor designed to run at speeds of from 200 to 875 r.p.m. The motor ran quite sparklessly at all speeds, but when running near the upper speed limit showed a tendency to flash over sooner or later. By means of a pilot brush the distribution of the e.m.f.'s in the winding was investigated, and it was found that at a speed of 850 r.p.m. the voltage between one of the main brushes and the pilot brush reached a value of 805 volts, and the maximum voltage between segments rose to over 50 volts, although the average algebraical value of this voltage was only 12·8. The possibility of such excessive field distortion, and the consequent liability of the machine to flash over, should be carefully considered by the designer. A. H.

401. *Iron Losses in Induction Motors.* **T. F. Wall.** (Electrician, 58. pp. 752–754, March 1, and pp. 797–798, March 8, 1907. Écl. Électr. 51. pp. 23–26, April 6, and pp. 60–63, April 13, 1907.)—Using Bragstad's method [Abstract No. 1086 (1905)], the author has separated the iron losses in a 7-h.p. motor into the low-frequency losses due to the rotation of the main flux and the high-frequency ones due to the flux pulsations arising from the periodic variations of reluctance brought about by the motion of the rotor teeth past those of the stator. The extent of the flux pulsations in the stator and rotor teeth was then investigated by means of search coils, and from the results so obtained the losses due to these pulsations were calculated by using a formula due to Arnold. The results obtained were found to be in very fair agreement with those found by Bragstad's method. A. H.

402. *Series* v. *Parallel Windings for Alternating-current Motors.* **R. E. Hellmund.** (Electrical World, 49. pp. 388–389, Feb. 23, 1907.)—Although

a series connection of all the coils is preferable to a parallel one in the case of *generators*, the author is of opinion that in the case of certain *motors*, such as single-phase commutator motors, the parallel connection is frequently quite as good, if not better. This opinion is based on the consideration that if owing to eccentricity of the rotor or any other cause the reluctances of the different magnetic circuits are different, then, since with a series connection of coils the magnetomotive force acting around each magnetic circuit is the same, the fluxes will be different, giving rise to a magnetic side-pull which will increase the frictional loss, and to internal currents in the armature which will increase the armature copper loss. With a parallel connection of the coils, on the other hand, the fluxes will adjust themselves to equality, and the internal armature currents will disappear; although the stator copper loss will be greater than with a series arrangement of the coils. The question resolves itself, therefore, into a choice of the member in which the increased copper loss is to be allowed to take place. A. H.

403. *Motor-generators* v. *Rotary Converters.* **P. M. Lincoln.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 217–225, Feb., 1907.)—The synchronous motor-generator, the induction motor-generator, and the rotary converter are compared with each other as regards: (1) reliability; (2) voltage regulation; (3) possibility of regulating voltage of transmission line by adjustment of power-factor; (4) efficiency; (5) cost; (6) parallel operation; (7) starting. In making the comparisons the author assumes the voltage of the transmission line to be so high that step-down transformers will be required in each case. As regards (1), (4), and (5), the rotary converter has a distinct advantage. With regard to (6), all methods are equally good; the converter is at a disadvantage as regards (2) and (3), and, to a slight extent, as regards (7). The above results would seem to indicate that there are but few cases where the motor-generator should be used in preference to the converter. A. H.

REFERENCES.

404. *Formulæ for Armature Windings.* **N. Gennimatás.** (Elektrotechnik u. Maschinenbau, 25. pp. 231–234, March 24, 1907.)—The author establishes a number of formulæ for determining the number of groups of conductors included between two neighbouring commutator segments in the case of singly re-entrant windings. A. H.

405. *Commutation in Single-phase Motors.* (Electrical World, 49. p. 306, Feb. 9, 1907.)—A brief description of some patents recently granted to M. Latour (U.S. Pats. 841,257, and 841,543, 4, 5). Three of these relate to the use of multiple armature windings connected to consecutive commutator segments, the width of each brush being insufficient to bridge two segments belonging to the same winding. The new features relate to arrangements of the windings, which give a steady progression of the phase of the e.m.f. without any increase in the number of slots. This object is attained by varying the winding pitch of the various turns composing a coil [see also Abstracts Nos. 327 and 455 (1906)]. **R. Lundell.** (Ibid. p. 514, March 9, 1907) points out that a similar arrangement was patented by himself in 1902. A. H.

406. *Single-phase Motors.* **H. R. Speyer.** (Elect. Engin. 39. pp. 150–153, Feb. 1, and pp. 189–190, Feb. 8, 1907.)—Some general notes on single-phase motors, with special reference to recent types, and curves embodying the results of tests of the Osnos, the Schüler, and the Fynn-Alioth motor. A. H.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

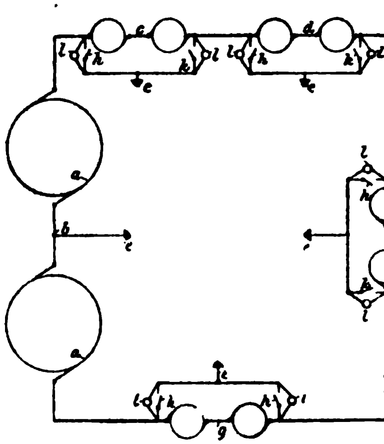
ELECTRICAL DISTRIBUTION.

407. *Voltage Drop in Transmission Lines.* **R. D. Mershon, C. P. Fowler.** (Elect. Journ. 4. pp. 137–155, March, 1907. From The American Electrician.)—The percentage drop along a given transmission line at a given power-factor of the load is conveniently determined by means of a diagram devised by Mershon. Examples are worked out to illustrate the use of this diagram. The methods of arranging the conductors of a transmission line so as to secure symmetry and avoid inductive interaction are next discussed. An ingenious method is described by Mershon for determining the actual voltage at the far end of the line from the generating station without the use of any pilot wires. Connected in series with one of the line wires is a non-inductive resistance and a reactance, so proportioned as to give a ratio equal to that of the resistance and reactance of the line. Across the terminals of these is connected a voltmeter in series with the secondary of a transformer whose primary is across the generator terminals. The ratio of transformation is chosen so that the secondary e.m.f., the drop over the non-inductive resistance, and that over the reactance, are proportional respectively to the generator p.d. and the resistance- and reactance-drops along the line. The vectorial resultant of these three voltages as read by the voltmeter is clearly proportional to the p.d. at the receiving end. This method of ascertaining the voltage at the far end of the line has proved entirely satisfactory. Fowler supplements Mershon's article by working out a number of additional examples, and extends the table of drops in various cases to conductors of larger size and for greater distances between them. A. H.

408. *Electric Power Transmission.* **F. Darlington.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 73–82, Jan., 1907.)—The author classifies natural water-powers according to their liability to interruption by dry seasons, &c., and the loads to which they are applied according to the load-factors. He then discusses the preliminary data for hydraulic developments, and the conditions which arise in operation. As an example, details are given of an undertaking in the Southern Appalachian Mountains, capable of developing 4,140 e.h.p., 66 hours per week, and 6,860 e.h.p. except in dry seasons. The total cost of construction was £188,000, and the total running cost £17,400; the estimated cost per h.p. delivered was £2·75 per annum. These figures exclude transmission cost and profit. The cost of steam power would have been £4·85 per annum per i.h.p. For power available only when the water supply was ample the cost per annum would be £0·97 per e.h.p. The costs are only relative, certain items being omitted. A. H. A.

409. *Improvements in Continuous-current Series-supply Systems.* (Engineering, 83. p. 331, March 8, 1907.)—Two inventions, due to J. S. Highfield, are described. The first [Brit. Pat. 1,946 of 1906] relates to means whereby the occurrence of a fault on any section of the line need not be attended with interruption of the supply, the supply being maintained while the faulty section is cut out and the fault repaired. This is accomplished by the method illustrated in the Fig., in which *aa* denote two generators at the central

station, *e* being a permanent earth connection to the junction *b* of the generators. Substations are shown at *c*, *d*, *f*, and *g*. At each substation voltmeters *ll* are provided, which on one side are connected to earth, and in parallel with them are arranged earthing switches *kk*. Normally the readings of the voltmeters will rarely or never sink to zero. If, however, a fault occurs on the line between two stations, the voltmeters connected to the ends of the faulty section will both drop to zero. The attendants at the two stations then establish the corresponding earth connections, thereby cutting out the



faulty line. This has the effect of splitting up the system into two parts, each of which is supplied by a section of the generating plant. The second invention [Brit. Pat. 1,947 of 1906] relates to means for utilising the earth as a return conductor. This is ordinarily impossible with high-voltage circuits on account of the damage done to piping laid near the surface of the earth. The inventor proposes to sink deep wells at the earthing stations or points, each well containing an insulating shaft, through which the conductor to be earthed is carried down to a conducting mass (such as an iron chain) at the bottom of the shaft. Earthing may be effected in this way at any required depth—100 or 200 ft. below the surface. Where possible the well is sunk until a wet stratum is reached. A. H.

410. *Methods of Leading High-voltage Transmission Lines into Power-houses and Substations.* **A. Meyers.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 167–182, Feb., 1907.)—An account is given by the author of the successive methods tried by the Telluride Power Co. of leading high-voltage lines into buildings. The earliest design, used on a system with 44,000 volts between the lines on a star-connected bank of transformers with the neutral point earthed, consisted of a 4 in. × 4 in. beam of oak with a 1-in. hole bored through its middle to carry the conductor, which was encased in a vulcanite tube. The beam was 5 ft. long; it was carefully paraffined and passed through a tight-fitting hole in the wooden gable of the power-house. On the outside it was protected by a hood. This form of construction was found to give trouble in a driving storm of snow and sleet. The next type tried was similar to the first, but with the oak bushing omitted, the line being carried through an opening underneath the hood. In this case arcing was liable to occur over the transformer bushings, and was probably caused by snow being

blown into the building. Experiments were then commenced on a new insulating material, known as "fibre conduit," consisting of a fibrous body treated with a bitumen compound. This material when dry had a high dielectric strength and good insulation, but when exposed to the weather and allowed to get wet its surface insulation was found to be very poor. Bushings of this material were tried filled with ozokerite, and although they were well protected by a sheet-iron hood they were all destroyed during a storm. The latest design, which has so far proved to be entirely satisfactory, consists of a fibre conduit, which is erected in a *vertical* position on the ridge of the roof, and which carries a high-voltage insulator at the top. The conductor passes through the insulator down the conduit, and the space between them is filled up with refined ozokerite having a melting-point of 150° C. In order to secure a solid filling free from air-bubbles, the ozokerite is poured in very slowly, only a foot or so at a time, with half-hour intervals between consecutive pourings. The bushing, or conduit, is secured to the ridge-pole by means of wooden clamps bolted to the roof. This form of construction is extremely cheap, and does away with the necessity for a hood. A. H.

411. *Negative Feeders for Railway Systems.* G. I. Rhodes. (Amer. Inst. Elect. Engin., Proc. 26. pp. 149–165, Feb., 1907. Elect. Rev., N.Y. 50. pp. 526–529, March 30, 1907.)—The author investigates the relative merits of different arrangements of return feeders in reducing stray currents. The load is assumed to be uniformly distributed over the entire line, which is supposed to extend in one direction only from the power-house. The following cases are studied: (1) No copper in return circuit; (2) copper of uniform cross-section, bonded to rails at short intervals; (3) copper distributed to give uniform drop, bonded to rails at short intervals; (4) a single insulated negative feeder connected to middle point of rail line and to its end at the power station; (5) do., connected to middle point of rail line only; (6) several insulated feeders; (7) do., with feed-points maintained at the same potential. In each case the results obtained are considered when the negative bus-bar at the power station is (*a*) earthed and (*b*) insulated. Insulating the bus-bar very much decreases the leakage current in all cases, the decrease being in the neighbourhood of 80 per cent. The arrangement (5) gives the poorest results (for a given weight of copper). The best arrangement corresponds to (7), which reduces the leakage current to 1·2 per cent. of its value in case (1) when the bus-bar is earthed, and to 6·2 per cent. of this value when the bus-bar is insulated. Very little is gained by using more than two feeders. A. H.

412. *Electrolytic Effect of a Fault.* H. Bassett, Jr. (Soc. Chem. Ind., Journ. 26. pp. 180–182; Discussion, p. 182, March 15, 1907. Electrician, 58. pp. 1009–1010; with Discussion, April 12, 1907. Abstract.)—An earth occurred on a cable carrying 460 volts at Brownlow, near Liverpool. The cable had been laid in a wooden trough, filled with bitumen, which was covered with a wooden lid, the soil being porous sandstone. The bitumen had been cracked by traffic in the roadway, and water was then able to leak through to the insulated cables. The top of the trough was burnt through, and a large amount of a hard substance, probably 2 lbs. in all, was found to have formed. The crevices in the mass were filled with bright liquid metallic globules, which were found to consist of an alloy of sodium and potassium. On analysis the hard substance was found to contain KOH, 33·37; NaOH, 32·26; K (liquid alloy), 1·00; Na (liquid alloy), 0·8; the rest being sand, earthy matter, and bitumen. The alkali was almost certainly formed

by the electrolysis of the salts dissolved in the surface water. The hydrogen formed by the transformation of the alkali metal into hydroxide might under certain conditions have caused an explosion. A somewhat similar case was recently noticed in a basement in the University of Liverpool, where some of the switches were covered with a white efflorescence, which was found to consist of sodium and potassium carbonates. This was also probably caused by the leakage of moisture through the walls from the outside soil. W. H. S.

413. *Electrolytic Lightning Arrester.* **C. C. Garrard.** (Electrician, 58. pp. 858–859, March 15, 1907.)—Referring to Jackson's paper [Abstract No. 167 (1907)], the author points out that an electrolytic arrester had been patented by Ferranti in 1901 [Brit. Pat. 25,426], but the patent was allowed to lapse. Some experiments carried out with this form of arrester are described. The arrester consisted of a pile of shallow dishes of aluminium, separated from each other by about ½-in. pieces of ebonite. One of the solutions used was bichromate of potash. By pouring the solution into the top dish slowly all the dishes were filled in turn by the solution running over the edges from one dish to another. Such an electrolytic resistance was found to give excellent results when placed in series with a spark-gap, as the latter could without any risk be set very near the working voltage, thereby affording very safe protection to the line. Further, it was found that the resistance not only effectively prevented any large rush of current from the generators, but also suppressed any surgings such as frequently result from free arcing in air. This conclusion was further verified by some experiments on a 2,000-volt continuous-current system. A spark-gap, consisting of a pair of horns, was first connected directly across the bus-bars, having in circuit with it a long, thin fuse. On switching off any appreciable current an inductive voltage-rise took place, which was shown by the blowing of the fuse. The electrolytic resistance was next connected directly across the bus-bars, in parallel with the horn-gap and its series fuse, and the experiments were repeated. Even when rupturing much larger currents no discharge across the gap occurred, and the fuse never blew, proving the power of the electrolytic resistance to suppress inductive rises of voltage. A. H.

414. *Relative Advantages of Steam and Electric Winding.* **A. Wallichs.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1–11, Jan. 5, 1907. Paper read before the Bezirksverein an der Niederen Ruhr. Engineer, 103. pp. 336–338, April 5, 1907.)—The writer sets as first condition of a winding machine absolute certainty of uninterrupted service; following this consideration comes that of cost, which in turn is made up of capital cost and running cost. Up to 10 years ago steam engines used for winding purposes were small and of exceedingly inferior quality, and corresponded to the class which in continuous running have a steam consumption of some 20 kg. per i.h.p.-hour. Since then, however, very great improvements have been introduced, and during the last few years the process of improvement has been greatly accelerated by the at one time threatened competition of systems of electric winding. The writer reviews these systems of electric winding, and acknowledges their high state of development and their excellent qualities generally, and also admits that they afford nearly as good certainty of uninterrupted service as can be obtained by steam winders. They cannot, however, compete with the most modern steam-winding equipments, either as regards first cost or operating costs. A great deal of data is set forth in tables, and appears conclusive on this point. The final com-

parison is of estimates on a plant for raising 900,000 tons per year. A working day consists of two shifts of 7 hours each, and the useful load per lift is 5·6 tons. The depth is 800 m. The steam pressure, whether the winding is direct by steam or through the intermediary of electric winders, is 12 atmos. Although the writer believes that the steam winder is actually more economical in steam consumption than the electric winder, nevertheless, in order not to favour his own views, he ascribes a steam consumption of 12 kg. per shaft h.p.-hour for the electric winder, and 18 kg. per shaft h.p.-hour for the steam winder. In order not to needlessly complicate the comparison, the capital cost of the steam-raising plant is not entered into, but instead the assumption is made that the total cost for steam raising, including capital cost and running cost, amounts to 1s. 8d. per ton of steam. For the rest of the plant the capital cost for steam winding amounts to £7,500 as against £22,000 for electric winding. The running costs are obtained from the capital costs by taking in both cases 15 per cent. of the capital outlay to cover interest and depreciation, and adding to this the much smaller costs incident to labour and repairs, and finally adding the steam costs. The result is that for steam winding the cost per shaft h.p.-hour amounts to 0·415d. as against 0·596d. for electric winding. The electric winding thus costs some 44 per cent. more than the steam winding. The writer also adds the case where, instead of putting down a special electric generating plant, the electrical energy is obtained from some other source at a cost of 0·36d. per kw.-hour. The assumption is made that a shaft h.p.-hour requires 1·6 kw.-hours, and on this basis the total cost per shaft h.p.-hour is just about twice the cost for steam winding. The writer then figures backwards, and finds that in order that the cost for electric winding shall not exceed the cost for steam winding the electrical energy must be supplied at a cost of 0·072d. per kw.-hour—a price which, he points out, is much lower than is ever likely to be realised. The reason that the steam-winding plant should be, both as regards capital and running costs, so much the cheaper, lies partly in the great transformation losses inherent to electric winding. These amount on the average, from the indicated output of the generating plant up to the work done in the shaft, to some 55 to 58 per cent. In conclusion, the writer points out that while, for large undertakings, steam winding is inevitably more economical, nevertheless in the case of light work, as regards load and height, electric winding is often quite convenient, and is the more justifiable when many other processes are being worked electrically.

H. M. H.

ELECTRICITY WORKS AND TRACTION SYSTEM.

415. *The First Electric Reversing Rolling-Mill at the Hildegarde Ironworks.* **D. Geyer.** (Stahl. u. Eisen, 27. pp. 121–126, Jan. 23, and pp. 162–166, Jan. 30, 1907. Paper read before the Hauptversamml. des Vereines Deutsch. Eisenhüttenleute, Düsseldorf, Dec. 9, 1906.)—The electric generating plant at these ironworks comprises three steam turbine generating sets, with an aggregate capacity of 5,000 kw. One of these sets is of the Parsons type, and is of 3,150 kv.a. capacity; the other two are of the A.E.G.-Curtis type, each for a capacity of 1,250 kv.a. This generating plant has been installed for the purpose of centralising the heretofore scattered steam plants of these works. The installation would not have been undertaken exclusively for the purposes of the reversing rolling mill, but in planning for the centralisation of a large amount of other work the pre-calculations indicated that it would

be in the interests of economy to also change over the reversing rolling mill to electric driving, notwithstanding the severe conditions. The rolls had, prior to this change, been driven by a steam engine with a cylinder of 1,200 mm. diam., and a stroke of 1,250 mm., and with an admission pressure of 6 atmos. The electric driving of the rolls is accomplished through the intermediation of an Ilgner set, comprising a 2,500-h.p. 3,000-volt induction motor direct-connected to two 1,500-kw. continuous-current generators, one on either side of the motor. Between the motor and the two generators are carried two flywheels, each of 26 tons weight, and with a peripheral speed of 80 m. per sec. Between the motor and these flywheels yielding couplings (Polysius type) are introduced. The two dynamos driven by the motor are connected in series, and have each a normal maximum voltage of 500 volts, thus giving, in series, 1,000 volts. Their subdivision is a mere matter of designing. The synchronous speed of the Ilgner set is 375 r.p.m., and its slip is automatically regulated down to 320 r.p.m., and in some cases where abnormal torques are required, down to 300 r.p.m., by means of a liquid rheostat, which is controlled by the current flowing to the stator windings of the main induction motor. The three continuous-current motors driving the rolling mill are direct-connected with one another, and are to be regarded as the equivalent of a single motor; their subdivision into three motors was chosen with a view to reducing the inertia of the rotating system. The three motors in series are supplied from the 1,000-volt continuous-current end of the Ilgner set. There is also supplied a small exciter motor-generator set consisting of an induction motor driving two continuous-current generators. One of these generators serves for the excitation of the shunt windings of the Ilgner dynamos and of the rolling-mill motors. The other dynamo of this small set supplies special compound windings provided for strengthening the field of the motors in the case of sudden abnormal fluctuations in the load, and thus brings about a decrease in speed, and relieves the line of the overload which would otherwise be occasioned. The subsequently verified precalculations showed that by these means the rolls should be accelerated from rest up to a speed of some 120 r.p.m. in less than 4 sec. The torque required, when taken in conjunction with these rapidly varying speeds, leads to instantaneous loads at the rolls, ranging well up toward 10,000 h.p. These loads are separated by intervals of less than 10 sec., and hence recur more than six times per min. In spite of these rapid load-changes, the Ilgner set so effectively equalises out the fluctuations that the load imposed on the generating station is relatively steady at the value of some 550 h.p. The Ilgner set may be run up from rest to its normal speed of 375 r.p.m. in some 5 min. if supplied with energy at the rate of some 500 or 800 kw., and, of course, in less time if supplied with proportionately more energy. The power required when running the Ilgner set unloaded amounts to some 120 kw. The continuous-current dynamos of the Ilgner set are provided with Deri windings. These machines are proportioned for a normal output of 1,500 kw. each, and for a maximum output of 3,750 kw. each, at 500 volts per machine. The secondary circuit-breaker is set at 9,000 kw. The GD^2 of the armatures of the three rolling-mill motors amounts to 180,000 kg.-m.^{2}, and it was with a view to obtaining so low a value that three motors were used, *i.e.*, in order to obtain armatures of small diam. In some other reversing rolling-mill work which the A.E.G. has in hand, the subdivision is only carried to two armatures for a plant of some 15,000 h.p. max. load, and in another case for a plant of 7,500 h.p. max. load a single armature is employed. Tests of the plant have led to results fully equal to the most sanguine expectations. The plant has

capacity for accelerating the rolls in from 2 to 2¼ sec. from zero speed up to 110 r.p.m. when running light, and when doing work requiring fluctuations of load from zero to 10,000 h.p. of the rolls, the accelerating ratio is nearly as great. The fluctuations of energy from the central station are only of the order of 2 per cent. of its total rated output, under these wide fluctuations of load at the rolls. Only in exceptional instances do the fluctuations at the generating station amount to as much as 100 kw. above and below the mean value of 500 kw. The energy consumption from the central generating plant amounts, according to the nature of the product, to some 20 to 60 kw.-hours per ton of completed product as rolled from the raw material. Complete data of the results are shortly to be published. H. M. H.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

416. *Steep-grade Railways without Rack.* **Calzolari.** (Elettricità, Milan, 28. pp. 31–34, Jan. 18, 1907. From the "Ingegneria Ferroviaria.")—Various systems have been developed for providing adhesion for steep-grade railways independently of the weight of the locomotive by means of wheels pressed horizontally against a third rail. Such a line was constructed by Fell over the Mont Cenis road before the completion of the tunnel. Hanscotte, of the Fives-Lille, has developed a system of this description in which the wheels giving the additional adhesion are pressed against the rail by compressed air. The system has been applied to an electric tramway at La Bourboule, opened in Aug., 1904, and to a steam railway from Clermont-Ferrand to the summit of the Puy-de-Dôme, to be opened shortly. The max. gradient is 12 per cent. The third rail weighs 27 kg. per m. and is 180 mm. high. The locomotives have three pairs of coupled axles and weigh 32 tons. They have two pairs of wheels bearing on the middle rail, each pair being capable of exerting a pressure of 24 tons on the third rail, thus giving a total weight effective for adhesion of 80 tons. The following speeds have been attained on the steepest part of the line :—

Locomotive with 2 coaches (18 tons), 15 km. per hour
" " 3 " (25 "), 12 "
" " 4 " (32 "), 10 "

A. E. L.

417. *Electric Traction on Railways.* **L. B. Stillwell** and **H. St. C. Putnam.** (Amer Inst. Elect. Engin., Proc. 26. pp. 1–64, Jan., 1907. Abstracts in Street Rly. Journ. 29. pp. 191–202; Discussion, pp. 202–204, Feb. 2, 1907. Elect. Rev., N.Y. 50. pp. 186–190, Feb. 2; 225–229, Feb. 9, and pp. 268–269, Feb. 16, 1907. Electrician, 58. pp. 758–761, March 1, and pp. 801–804; Discussion, p. 804, March 8, 1907. Écl. Électr. 51. pp. 29–33, April 6, 1907.)—The authors summarise the advantages of electric traction compared with steam, and cite examples of traffic developed by frequent-service interurban electric lines. The effect of introducing electric traction on the New York elevated and surface lines is strikingly shown by diagrams. Estimates of the comparative cost of steam and electric traction are based upon the official statistics for the former, and known results obtained in practice with the latter. The single-phase alternating-current system of traction is stated to be the only kind worth considering in connection

[1] Non-electrical Automobiles are described in the Section dealing with Steam and Gas Engines.

with the general problem, and it is assumed that the trolley wire is supplied at 11,000 volts, power being transmitted to a distance of 150 miles in each direction from each power station, at a pressure of 60,000 volts. Tables are given showing the ascertained costs of maintenance of way and structures, and of equipment, under steam conditions, and the effect upon these items of electrical operation is considered in detail. The cost of high-class overhead construction for two tracks is estimated at £2,150 per mile; for single track, £1,000 per mile, with steel poles and brackets. Experience shows that the maintenance of electric locomotives is one-third of that of steam locomotives, and probably half the number of locomotives will suffice for the same work. Fuel cost is expected to be reduced by one-half, and a case is quoted where the works cost of producing 1 kw.-hour is 0·2d. The power required for 300 miles of line fed from one station is estimated at 4,000 kw., and with single-phase 25-cycle motors 75 per cent. of the energy supplied at the bus-bars will be effective for traction. The cost per kw.-hour effective for traction is estimated at 0·4d. Details are given of the passenger and freight services contemplated, with diagrams showing train characteristics. The following table summarises the principal expenses, which are detailed under 58 items in the complete tables given in the paper :—

Item.	Cost of Operation of U.S. Railways by Steam. Average of 5 years (1901–1905). Per Cent.	Estimated Cost of Operation by Electricity. Per Cent.
Maintenance of way and structures	21·008	22·354
Maintenance of equipment	19·524	12·287
Conducting transportation	55·540	48·454
General expenses.........................	3·938	3·933
Grand total	100	82·028

The authors estimate that if all the railways of the United States were operated by electricity on the single-phase alternating-current system as in use to-day, the cost of operation, which in 1905 amounted to approximately 290 millions sterling, would be reduced by about 52 millions; power plant producing 12,500 million kw.-hours per annum would be required, the maximum output being 2,800,000 kw., and the average output 10 kw. per mile of line (7 kw. per mile of track). The saving in operating expenses would more than suffice to cover the increase of fixed charges, and the earning power would be greatly increased. Nevertheless, an immediate change would be undesirable, and the authors urge the necessity of deliberation. Standardisation is essential, but with caution, and the authors put forward the position of the third rail and of the overhead conductor, and the frequency used on alternating-current systems, for consideration. Very strong reasons are pointed out for the retention of the 25-cycle standard of frequency in general use, but notwithstanding these the authors believe that the advantages of 15 cycles in connection with the construction and working of single-phase motors outweigh all other considerations. The saving in cost of locomotives for the lower frequency to operate the existing railways would be more than twice the increase in cost of the stationary plant, and further economies would be effected in operation and in the copper used for overhead and return conductors.

F. J. Sprague, A. H. Armstrong, G. R. Henderson. (Street Rly. Journ. 29. pp. 249–254, Feb. 9, 1907.)—Referring to the *discussion*, F. J. Sprague emphasises the possibilities still open to the direct-current motor, thanks to the introduction of commutating poles and to the improvements in the construction of gearless motors as used on the New York Central Railroad. A. H. Armstrong regards the claim for superior economy on the part of the electric locomotive as unlikely to carry weight, compared with the greater advantages of increased tonnage capacity and reduction of delays in operation, especially in connection with freight traffic. He considers standardisation premature in the light of present knowledge, the relative advantages of the various systems not having been sufficiently ascertained. G. R. Henderson admits the pre-eminence of electricity for suburban service, but questions its superiority for general conditions. He doubts that one electric locomotive can replace two steam locomotives, and criticises adversely the economies in operation claimed by the authors. The maximum output is estimated to be twice that given in the paper, and the cost of power plant therefore much greater, so that the reduced cost of operation loses its importance. A. H. A.

418. *Cost of Steam and Electric Locomotive Operation.* **G. B. Werner.** (Eng. Mag. 32. pp. 888–889, March, 1907.)—The figures for the electrical project are based upon the use of the three-phase system. For the cost of steam locomotive operation the figures employed were compiled from the annual report of the railroad for the particular division upon which a complete project for electrification was estimated. The section to be electrified is a part of the main line, double-tracked, 78 miles in length. The profile shows a fairly mountainous character, with maximum grades of 2·0, 2·2, and 2·8 per cent. for 11·2, 8·5, and 15·8 miles. The rest is either level or consists of grades between 0·8 and 1·0 per cent. The alignment shows many curves of large radius. The traffic largely consists of freight trains from 600 tons to 1,400 tons with schedule speeds from 8·7 to 19·6 m.p.h. The passenger trains average 250 tons and make a schedule speed of about 27 m.p.h. The ton-miles per year are enumerated as follows: Slow freight, 1,128,500,000 ton-miles; fast freight, 308,000,000; passenger, 111,000,000; total, 1,547,500,000 ton-miles. This ton-mileage, for an average train weight of 700 tons, corresponds to 2,211,00 revenue train-miles per annum. From a study of the time-table of the road, and based on an average daily mileage of 140 per locomotive, it appears that 48 locomotives are required for the revenue-bearing service of 2,211,000 train-miles (assuming no pushers). The report shows that about 20 per cent. of the locomotives are continually undergoing repairs, or otherwise temporarily out of service, and 11 per cent. are required for switching service; so that a total of 60 locomotives are required. The average initial cost of locomotives for this line (Consolidation and Pacific types) is $18,260 each. Taking the round number of $18,000 the fixed charges will then be based on an initial investment of $780,000. From a careful examination based upon the report the fixed charges on the locomotives are found to amount to about 11 per cent. of the total.

Electric Operation.—The estimate included an entire electric equipment, comprising a power-house, located at about the centre of the system, of 10,500 kw. capacity in three steam turbo-generator units; a double transmission line, operating at 88,000 volts; 18 substations of 12,250 kw. aggregate capacity, distributed along the line, near to the tracks; overhead working conductors throughout the division for both tracks, sidings, &c., with a

normal pressure of 3,000 volts; six 66-ton passenger locomotives and twenty-two 90-ton freight locomotives. The annual cost of operation was divided into cost of generating energy, cost of distributing energy, and cost of locomotive operation. Each of these amounts included fixed charges (interest, taxes, insurance and risks, depreciation), labour, maintenance, and repairs. In the cost of generation of energy is included, of course, the fuel item. The resulting unit costs were as follows :—

(*a*) Generation, per kw.-hour	0.46180 cent
(*b*) „ „ ton-mile	0.01619 „
(*c*) Distribution per kw.-hour	0.25500 „
(*d*) „ „ ton-mile	0.00898 „
(*e*) Power delivered at locomotive, per kw.-hour $(a + c)$	0.71680 „
(*f*) „ „ „ „ ton-mile $(b + d)$	0.02517 „
(*g*) Locomotive operation per ton-mile	0.01440 „
(*h*) „ „ inclusive of power per ton-mile $(b + d + g)$	0.03957 „

This total of 39.57 cents per 1,000 ton-miles, or 27.69 cents per revenue train-mile (for an average train weight of 700 tons) includes every amount chargeable to locomotive operation, except the repairs and depreciation to the roundhouse-shop. For these latter, fair estimates were made by comparison with corresponding data for steam locomotives. Taking fuel at $1 per ton, the figures in the following table are deduced for the cost per revenue train-mile :—

	Steam.	Electric.
Repairs to locomotives	3.32 cents	1.67 cents
Wages, engineers and firemen	8.75 „	—
Wages, roundhouse-men	1.62 „	—
Wages, motormen and helpers	—	5.38 „
Roundhouse expenses	0.31 „	1.25 „ (for these four items)
Roundhouse and shop, repairs and renewals	1.07 „	
Shop expenses	0.20 „	
Shop machinery and tools, repairs and renewals	0.91 „	
Fuel	9.77 „	—
Fuel station, operation	0.028 „	—
Water supply	0.81 „	—
Fuel and water station, repairs and renewals	0.26 „	—
Power delivered at locomotive	—	17.62 „
Oil, waste, grease, and supplies	0.99 „	0.23 „
Interest	1.41 „	9.76 „
Insurance and risks	0.58 „	0.63 „
Depreciation	2.12 „	1.40 „
Total	36.85 cents	28.94 cents

The revenue train-mile cost is about 15 per cent. greater than the locomotive-mile cost, since the latter mileage includes the non-revenue-bearing shifting service. H. M. H.

419. *Single-phase* v. *Third-rail System for Main-line Railways.* (Electrician, 58. pp. 918–919, March 29, 1907.)—The relative advantages of the single-phase and third-rail systems in connection with the problem of main-line electrification are compared from the point of view of ease of operation and reliability of service. Inspection of the line and repairs are carried out much more

easily with the third-rail system, and any interruptions which may occur are likely to be of much shorter duration. The reduction in the number of substations possible in the case of the single-phase system is a doubtful advantage, as for the sake of reliability it is advisable to subdivide the line into fairly small sections. The third-rail system would therefore appear to be preferable, especially as it appears doubtful if any great saving in capital cost could be effected by adopting the single-phase system—at any rate under the conditions characteristic of English main lines. A. H.

420. *Notes on Speed-time Curves.* **T. W. Simpson.** (Street Rly. Journ. 29. pp. 244–248, Feb. 9, 1907.)—Starting from the ordinary characteristic curve of a given series motor, the author obtains a series of curves connecting the tractive effort in lbs. with the speed in miles per hour for different values of the gear ratio. Dotted lines corresponding to a particular current value are drawn across the curves. Finally, the tractive effort required to overcome the train friction is plotted against the speed. From these curves one is selected corresponding to a particular gear ratio, and with the aid of this, the "general speed-tractive-effort curve," and a formula derived from first principles, a series of speed and distance time curves are plotted. The series consists of the following curves: (1) Speed and distance time curves for acceleration (parallel running), plotted for gradients ranging from + 8 to − 8 per cent. (assuming an increase and decrease in train friction of 20 lbs. per ton for each per cent. of grade. (2) Speed and distance time curves for retardation during coasting plotted for various gradients. (3) Similar curves for retardation during braking. (4) Similar curves for retardation on various gradients (parallel running). (5) Similar curves for acceleration (series running); plotted for various gradients. (6) Similar curves for acceleration, coasting on down grades; plotted for various gradients. From these six sets of curves it is a simple matter to plot a speed-time curve and current-time curve for this equipment for any profile. For the added resistance due to curvature an equivalent gradient is taken equal to 0·05 per cent. grade for each degree of curvature. With the aid of such curves questions relating to the most economical grade, safe radius of curvature, &c., may be readily determined. A. G. E.

421. *Newell-Westinghouse Electric Braking System.* (West. Electn. 40. pp. 123–125, Feb. 9, 1907. Elect. Rev. 60. p. 508, March 29, 1907.)—Extracts from U.S. Patents 841,709, granted to F. C. Newell, and 841,710 granted Newell and E. H. Dewson. Both patents are assigned to the Westinghouse Air Brake Co. The first patent provides improved means whereby the brakes may be actuated independent of the running controller. This is obtained by an apparatus called a "braking controller," which consists of a switch and a resistance controlling-device mounted on the same shaft and operated by the same handle. By a single movement of the handle the running controller is disconnected from the supply circuit, and is connected with the braking controller in the local braking circuit, and also at the same time the brakes are applied. The brakes may be controlled either by the running or braking controller. By movement of either of these controllers the resistance of the local braking circuit is varied, and therefore the force of braking is also varied. A diagram of connections for car operation and braking is given showing the application of the improvement to a car equipped with two motors, a magnetic braking device, and with a braking controller at each end of the car. The diagram is adequately explained. The second patent

provides improved braking controller and circuit connections, which permit the braking to be more readily and effectually controlled. The local braking current, and therefore the braking force, is controlled by means of a variable-resistance shunt winding around the fields of the generators. This shunt circuit is automatically closed by a voltage regulator and its resistance is varied by hand. The shunt circuit is safeguarded by an improved arrangement of fuses. The braking controller provides means for holding the car on grades by supplying line current to the brake magnets, and it also provides means for ensuring rapid growth of the local braking-circuit current at initial braking by utilising the line current for exciting the fields of the generators. A diagram of connections is given for an ordinary car equipment of two motors and a running controller with improved braking controller applied thereto. A series of diagrams is also given illustrating the circuits corresponding with the various positions of the braking controller. A. G. E.

422. *Electric Traction on Canals.* **L. Gerard.** (Soc. Belge Élect., Bull. 23. pp. 501–541, Nov., 1906.)—A close comparison between the system of electric canal haulage adopted on the Erie canal [Abstracts Nos. 1584 (1905) and 516 (1906)] and that used on the Teltow canal. The author disputes an article by Köttgen (Elektrotechn. Zeitschr. 27. p. 746, Aug. 9, 1906), in which it is asserted of the American system, (*a*) that it is not new, having been anticipated by a German patent; (*b*) that the cost of the permanent way is three times as high as for an ordinary two-rail track; (*c*) that the cost of a tractor is scarcely less than that of the German pattern of the same type; (*d*) that the consumption of energy is practically the same in the two systems. Detailed estimates of first cost and running costs are given in support of the author's contention. A. E. L.

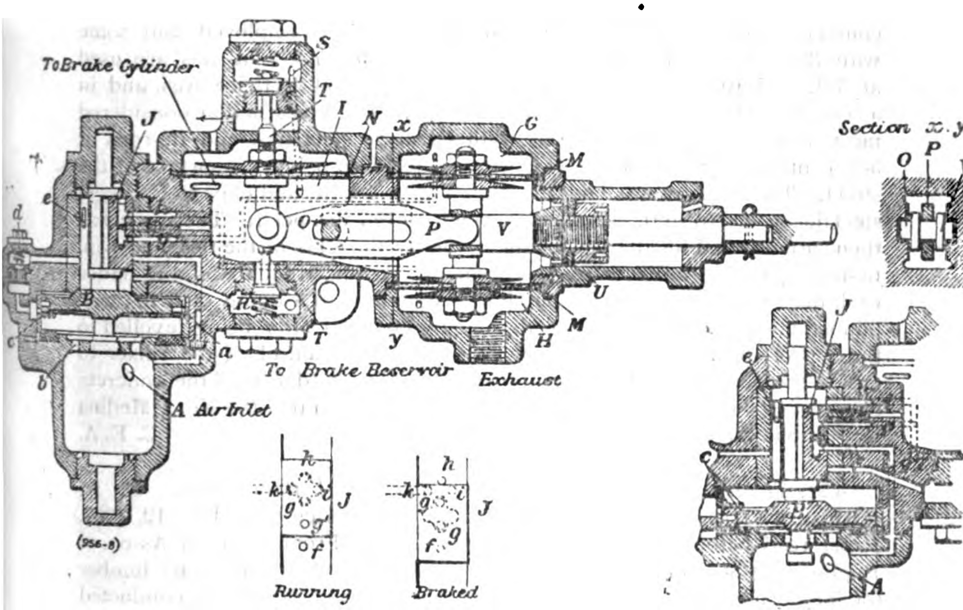
423. *Paving between Street Railway Tracks and Rails.* **B. J. T. Jeup.** (Street Rly. Journ. 29. pp. 240–242, Feb. 9, 1907. Paper read before the Indiana Engin. Soc., Jan. 17–19, 1907.)—There are three prevailing types of rails: The T-rail, the rail used in steam railroad practice; the girder rail; the grooved rail. This latter strictly speaking is a development of the girder rail. Railway companies advocate the use of a T-rail and put forward the following arguments in favour of this section over the grooved rail. (1) Less resistance to tractive force. (2) Ease of and better installation. (3) Long life of rails. (4) Greater safety of traffic, which appeals most. And (5) minimum track expense. In a city where the streets are wide it makes little difference as to the kind of rail used. But where the streets are narrow the municipal authorities rightfully demand a rail which offers the minimum obstruction to other vehicles, and which will cause the least derangement and deterioration of pavements along the rail, and also a rail which will be safe for the travelling public. A description is then given of the method of construction of a rail in use at Indianapolis, made to overcome the objection to the ordinary form of T-rail used by interurban companies, and to combine the advantages of both the T-rail section and the grooved rail. A heavy T-rail section of special design was rolled, weighing 91 lbs. to the yard. The depth is 7 in. A deep groove is formed by the use of a large nose block placed as a stretcher along the inside of the rail. The space between the nose blocks is paved in the ordinary manner with vitrified paving block. Paving between the rails is then dealt with. For terminal tracks the best and heaviest construction is none too good. In this city many forms of paving construction are used. Asphalt between the tracks, with a stretcher

of brick or granite on each side of the rail, a header of brick, with two stretchers of brick alternating; asphalt placed against the rail and against a Haydon block on the inside of the girder rail, with brick or stone block pavement. Creosoted wooden block is not good, as in time sufficient oil exudes to enable the blocks to absorb water and thus interfere with the alignment of the track owing to the swelling. Sheet pavement of any description is bad. It is now the generally accepted opinion that the paving between the track should be some form of block pavement, either brick or stone or asphalt block. C. E. A.

424. *Holding Power of Railway Spikes.* **R. I. Webber.** (Eng. News, 57. pp. 262–268, March 7, 1907. Engin. Experiment Station, Univ. of Illinois, Bull., No. 6.)—In these experiments the resistance of screw spikes to direct pull in various woods varied from 6,000 to 14,000 lbs., and of plain spikes from 3,000 to 8,000 lbs. in untreated, and 4,000 to 9,000 lbs. in treated timbers. The pull required to withdraw plain spikes 1/8 in. is from 2,000 to 3,500 lbs. in untreated, and 2,500 to 3,500 in treated timbers. The different sizes of spikes in use (9/16-in., 19/32-in., and 5/8-in.) offer practically equal resistance to withdrawal if of equal length; the resistance varies directly with the depth of penetration. The resistance of spikes having the Thiollier helical metallic lining [see Abstract No. 1229 (1906)] to 1/8 in. of withdrawal from hard woods was greater than that of ordinary screw spikes, but for further withdrawal was less. Spikes were also submitted to blows of a 100-lb. hammer falling 1½ ft., applied under the head, and a table gives the deflections after one and five blows. These varied from 0·19 to 0·32 in., and 0·69 to 1·23 in. for plain 9/16 in. spikes, and from 0·09 to 0·21 in., and 0·39 to 0·79 in. for screw spikes. The resistance to lateral displacement increases with deeper penetration, but the increase is practically negligible beyond 4 in. 5/8-in. plain spikes offer a slightly greater resistance than 9/16-in. Whilst the use of screw spikes on American railways is recommended, it is pointed out that in certain circumstances the practice of the Bavarian State railways could be followed with advantage. This consists in the use of the screw spike on the inner side of the rail and square spikes on the outer side. F. R.

425. *Chapsal-Saillot Compressed-air Brake.* (Engineering, 82. pp. 863–864, Dec. 28, 1906.)—In order to secure the maximum degree of safety, now that high-capacity rolling stock is being used more extensively, there are advantages in the use of a brake in which the braking action is independent of the wear of the shoes, and constantly adjustable to the load carried by each separate vehicle forming a train. These advantages are claimed to have been fully met by the Chapsal-Saillot brake, of which illustrations are given. In this brake the distributor works by the difference of pressure in the regulating reservoir and in the train pipe, and ensures the simultaneous filling of both reservoirs when the train is running; when braking it regulates the supply and the emptying, either gradual or complete, of the brake cylinder. A set of small rods connects the mechanical part of the distributor to the suspension springs, in such a way that the pressure let into the brake cylinder varies for a given difference of pressure in the train pipe, within large limits, with the loads on the vehicle. The regulating reservoir governs the action of the distributor and ensures uniformity in the braking along the whole train. The sole duty of the brake reservoir is to supply the brake cylinder. In the Figs. the distributor is shown in the running position. The air arrives

from the train pipe at A, raises the piston B, and fills both the reservoirs by flowing through the slits *a* and *b*, the holes *c*, and the valve *d*, thence through *e* and *f*. The three diaphragm chambers, G, H, I, communicate with the atmosphere through the slide-valve J, and the passages *g*, *h*, *i*, and *k*. The brake is then off. A reduction of pressure in the trainpipe causes the piston B to move downwards, the slide J uncovers the port *h*, the air from the regulating reservoir enters the chamber H, the chamber G communicates through *g* and *g'* with the pipe A, and the chamber I is closed to the atmosphere. The difference in pressure in H and G reacts on the diaphragms M and M′ and causes the lever P to turn round its fulcrum; the rod T raises the valve R and the brake reservoir supplies compressed air to the chamber I. This air drives forward the piston U, which draws with it the fork V and the



fulcrum of the lever, the travel being limited by the small rods, already referred to, according to the deflection of the vehicle. The relative length of the two arms of the lever P is regulated automatically, according to the weight on the axles. The valve R closes when the pressure acting underneath the diaphragm N balances the depression produced at G. If compressed air be supplied through the pipe the equilibrium is destroyed in I, the diaphragms act inversely, the valve S is raised and allows the evacuation of the air from the brake cylinder until proportionality in the pressures is attained. The brake can be put off gradually by successive admissions of air. The brakes are full off when the initial pressure is re-established in the compressed-air pipe, when the various parts take up afresh the position shown. C. E. A.

426. *Concrete Stringer, Concrete Stringer with Ties, and Steel Ties.* **F. D. Jackson.** (Street Rly. Journ. 29. pp. 100–108, Jan. 19, 1907. Paper read before the New York State Street Rly. Assoc.)—This paper treats, not of all the styles of construction used in Buffalo, but of two distinct types, viz., con-

crete stringers with and without ties, and solid concrete in the track. The tendency is in the direction of providing a foundation for the rails which shall be as nearly rigid as possible. The advisability of this has been discussed, but measurements of rails on a line operating a half-minute service prove that there is nothing to fear. Buffalo has carried the concrete stringer idea further than most roads, by laying a solid bed of concrete the entire width of the roadbed, 6 in. deep and 6 in. under the ties, instead of having a concrete beam under each rail. This style of construction is used with tracks laid in block paving, while in streets laid in asphalt a concrete beam 12 in. wide by 8 in. deep has been placed under each rail. Regarding concrete beam construction without ties, in each case the rail is 9-in. No. 94–204, with standard 12-bolt joint, with tie-rods at 8-ft. and 5-ft. centres, and toothing and asphalt. In the solid concrete construction 9-in. girder, mostly welded, is employed, but some with the standard 12-bolt joints. Yellow pine $5 \times 7 \times 7$ in. ties are used at 5-ft. and 10-ft. centres; tie-rods are employed at 10-ft. centres, and in a few cases brace tie-plates at 6-ft. centres. The construction considered most up-to-date is solid concrete with Carnegie steel ties, and tie-rods at 5-ft. centres. A trench 18 ft. wide was dug to 15 in. below the surface of the street. The 9-in. rail was laid and bolted with 4 bolts and clips to Carnegie steel ties spaced to 10-ft. centres, and weighing 19·7 lbs. per ft. The track was then surfaced and lined by blocking up under the ends of the ties, and $\frac{7}{8}$-in. tie-rods spaced at 5-ft. centres were put in. A 6-in. trench was dug under each tie. Concrete was then put into the trench to a depth of 6 in., well tamped under the rail, and then thoroughly pounded after being levelled to the top of the ties. Three ties were kept tamped ahead of the mixer to ensure thorough work at the ties. The pavers followed behind the concrete gang, using 8 in. of coarse gravel for a cushion, and on that the No. 1 Medina block stone was placed. C. E. A.

427. *Treated Wood-block Pavements for Street Car Tracks.* **F. A. Kummer.** (Eng. Record, 55. pp. 52–53, with Discussion, Jan. 12, 1907. Paper read before the Boston Soc. Civil Engin. From Journ. of Assoc. of Engineering Societies.)—Owing to the great demand for all heart lumber (of long-leaf pine) the prices are prohibitive, and tests are being conducted on a number of other woods, among which the black gum of the South promises the best results. In discussing the remedy for the buckling-up and swelling of the paving, it was recommended that the block should be as completely filled with preservative material as it would permit; and to render the ordinary creosote oil thoroughly waterproof, melted rosin was introduced along with the oil, which not only impregnated all parts of the block, but sealed up the pores. The general proportion of rosin used is 25 per cent., but it is according to the quality of creosote oil used. In laying the blocks tight joints should be used, as the water then runs off into the gutters. The best foundation is a rigid one without any cushion. The surface of a wood pavement must be kept uniform, and the usual method adopted is to true up the surface of the concrete with a mortar bed, and the blocks are laid in it before it has set and then tamped with an asphalt rammer until the surface is smooth and even. The size of block recommended is about 8 in. wide, 8 in. long, and $3\frac{1}{2}$ or 4 in. deep. For filling the joints clean, fine sand is favoured, used very dry and thoroughly swept into the joints, but it is found a cement grout joint will give better results. A pavement made under the above conditions should, in the author's opinion,

have under the heaviest conditions of travel a life of from 10 to 15 years. In the *discussion* of the paper attention was called to the wood-block pavement recently laid on Washington Street, Boston, where an unusual type of street-car track was used. The rails are supported on the usual tie construction, the ties being 2·5 ft. on centres, and supported in and on a continuous concrete beam extending 6 in. below the bottom of the ties, and about 5·5 in. above them. These beams are connected by an arch of concrete, which gives about 5·5 in. of concrete base in the middle for the wooden block pavement. It was decided to plaster with cement mortar next the rail its entire height just before putting in the concrete, which ensured intimate contact between the concrete and the rail and left no voids in which water could accumulate. The object of this form of track construction is to eliminate movement of the rail under passing cars as far as possible.

C. E. A

428. *Methods of Remedying the Interference of Foreign Current with Automatic Block Signals.* (Eng. News, 57. pp. 25–27, Jan. 10, 1907. Report presented to the Rly. Signal Assoc. Electrician, 58. pp. 896–897, March 22, 1907. Abstract.)—The track relays by which automatic signals are operated are liable to be affected by the stray currents from electric railways. Legislation is suggested in the direction of securing properly bonded tracks and return conductors. The following chief conclusions are embodied in the report but are not yet adopted by the Association : (1) When there is a crossing of an electric road with a steam road, batteries must be placed at each end of steam road track next to crossing, and battery current arranged to flow in direction with foreign current leading into track circuit, if foreign current is found to flow in a definite direction. The connections, through block section for control of signals, must be made by means of line wire circuits. If there is sufficient foreign current to improperly work the track relay when an insulated joint is broken down, the multiple track-relay arrangement should be used. (2) For situations where there are power-houses and foreign currents follow the track rails, although there may not be a crossing or connection with an electric road, the conditions should be carefully studied and information obtained as to the source, direction, amount and pressure of foreign current, and provision should then be made for removing or blocking out this current. (3) To minimise the effects of foreign current on line wire circuits, it is regarded as important that trunking be kept above the top of the ground, the rubber and other insulations be kept in first-class condition, and the common wire limited to a length of 10 miles. (4) For multiple arrangement of track-circuit relays, a resistance of 16 ohms is suggested for relay at battery ends and 4 ohms for the relay at the other end of track circuit. Further research should be made to establish the proper relation of the resistance, pick-up, and releasing point of the two relays. (5) For track circuits having but one relay, a resistance of 9 ohms is recommended for circuits 500 ft. and under, and 4 ohms for circuits above 500 ft. The size of wire and standard ground connection are also specified.

E. O. W.

429. *The Track Circuit as installed on Steam Railways.* **H. G. Brown.** (Inst. Elect. Engin., Journ. 38. pp. 107–116 ; Discussion, pp. 116–125, Feb., 1907. Electrician, 58. pp. 458–460 ; Discussion, p. 460, Jan. 4, 1907. Abstract. Elect. Engin. 39. pp. 26–28, Jan. 4, 1907.)—Present methods of employing track relays are fully dealt with in regard to the effective shunting, the nature of the relay, the battery (storage cells are preferable), the bonding of

the rails, insulation of joints, and general adjustments. The following points were brought out: Relays are of varying resistance, dependent upon the length of circuit and nature of battery used. Oak wood blocks with fibre between rail ends are used for dividing sections. Local contacts are carbon and platinum to prevent fusion. **A. H. Johnson** suggested the use of a mercury contact protected from weather and moisture by being immersed in a light oil. Sand on the rails partially insulates, and in some cases totally insulates, the wheels of vehicles. A light vehicle does not form a good shunt. There are two conditions which may make the track signal uncertain. But the author does not regard them as formidable. The minimum ballast resistance will be found to be from 4 to 12 or 18 ohms per 1,000 ft. With fang bolt construction in normally wet and poorly drained places it is not unusual to find but 1 or 1¼ ohms per 1,000 ft. A relay should work with 0·015 watt on steam railways. On electric railways a higher potential between the rails may be advisable. Copper bonds in tunnels and where sulphurous fumes are experienced are better than galvanised iron wire, which is sufficient in ordinary circumstances. **E. C. Irving** thought that galvanised iron was superior in all cases, owing to the diminished electrolytic action at point of contact of bond and web of rail. Curves are given of the shunts which will prevent the pick up and which will cause the drop of the armature, relatively to shunt and ballast resistances. E. O. W.

430. *Automatic Electric Signalling.* (Brit. Pat. 25,525 of 1905. Engineering, 83. p. 258, Feb. 22, 1907. Abstract.)—In M. Rathborne and H. Fielding's improved method of signalling on single-line tramways the overhead wires at or near each loop or signalling station are "cut out" by section insulators, and thus the wires between the two stations are normally "dead." The signalling apparatus of each wire is at the loop the car is proceeding to, and comprises an operating solenoid, the wiring of which is in circuit with the "cut-out" portion of the overhead wire and with the next length of the overhead wire beyond the loop, which communicates by the usual feeder with the generating station. The flange of the trolley makes the necessary contacts for working the semaphores. A car entering a section thus clears the section just left and blocks that which it is now occupying. E. O. W.

431. *Gardiner's Electrical Train Signals.* (Elect. Engin. 39. pp. 291–292, March 1, 1907. From the Rly. Engineer.)—A patent of A. Gardiner embodies, in addition to the usual track circuit and relays, insulated conductors of tee or any other suitable section laid in such a manner parallel to the track that contact can be readily obtained between them and any engine or other vehicle fitted with a shoe, trolley, brush, or other contact-maker. By connecting a signal battery at an appropriate point of a section, between the rail and the contact of the track circuit relay, it can be arranged to work a device on the engine. E. O. W.

432. *Power Signalling as Installed by the Underground Electric Railways Co., of London.* **B. H. Peter.** (Elect. Rev. 60. pp. 437–441, March 15, and pp. 481–485, March 22, 1907.)—Many details have already been dealt with in Abstracts Nos. 178 (1904), 660 (1905), and 882 (1906). The following additional information regarding control of signals, operation of points, and fogging apparatus is of interest. At interlockings, where it is necessary for a signalman to have control over the signals governing certain tracks, the

circuit through the track relays of each section is taken into the signal cabin, and there operates an "indicating relay," having an armature carrying three separately insulated platinum-tipped arms, which make contact against carbon studs. Current for operating signals over that section has to pass through these contacts, in addition to the contacts closed by the lever on the power frame. Consequently, if a track is occupied, it is impossible for the signalman to lower any signal reading over that track. The mechanical locking for interlocking the signal and point levers is done by means of small vertical steel bars engaging with tappets carried by horizontal sliding bars, one of which is operated by each lever. The reversal of a signal lever allows current to pass through contacts on the "indicating relays" for the section over which the signal reads, and thence to the valve admitting air to the signal motor. When a train enters a section, the indicating relay is de-energised, and the circuit is broken, in spite of the fact that the lever may still be in the reverse position. When a section is occupied, the control of the signal for that section is thus automatically taken from the signalman, it being impossible for him to again lower the arm until the track is clear. As it is of great importance that a signalman should know positively that a signal has gone to the danger position after the passage of a train, the return movement of each signal lever is controlled by an electric lock. The signalman is free to return the lever half way, breaking the signal circuit, but no further movement can be made until the lock is energised by current which has to pass through contacts on the signal, closed only when the arm is in the danger position. In the event of a signal failing to go to danger, the lever is consequently back-locked, and this prevents the signalman from either altering the position of the points, or lowering any conflicting signal. In addition to this "indication lock," certain signal levers are fitted with a back-lock, to prevent a signalman returning the lever and altering the position of points in front of a train after a signal has been accepted. This back-lock is similar in action to the indication lock, but does not come into action until a train enters the section immediately previous to the signal. The signal lever, if reversed, is back-locked until the train is clear of all points and crossings, and is then released by the track circuit. In all the cabins the number of levers is largely reduced by the use of "selection"; that is, one signal lever is used for operating several signals. The points are operated by pneumatic double-acting cylinders, the piston being connected to an escapement gear. The admission of compressed air to either end of the cylinder is controlled by a slide valve operated by two small cylinders, to which air is admitted through pin valves electrically operated, as on the signals. When a point lever is normal the circuit for one magnet is closed, and the air inlet to one side of the cylinder is held open. When the lever is reversed the circuit is opened for this magnet, and closed for the other one. The slide valve is moved, and air is admitted to the opposite end of the cylinder, the inlet to the "normal" end of the cylinder being at the same time opened to atmosphere. It is essentially necessary that the points should correspond in position with the lever, and to ensure this two indication locks are fitted to each lever. Each of these locks prevent the full movement of the lever, one preventing the lever being completely reversed, the other preventing the lever being put entirely back, until a circuit is closed at the points to release the lock. These circuits are not closed until the points are properly locked in their new position, and as, on account of the mechanical locking, the signalman is unable to reverse the required signal lever until he has completed the full movement of the point lever, the lowering of a signal

is a guarantee that the points are properly locked in the position indicated by the signal. For fog-signalling, both on the District Railway and on the open-air section of the Great Northern, Piccadilly and Brompton Tube, Clayton's machines have been adapted for automatic working. Each magazine is capable of holding 50 detonators. The attention required after once placing the magazine in position is very small. E. O. W.

ELECTRIC LAMPS AND LIGHTING.

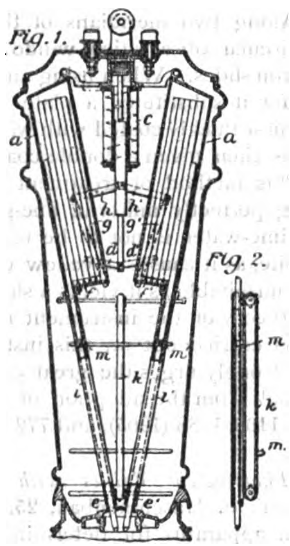
433. *The "Helia" Arc Lamp.* (Elektrotechn. Zeitschr. 28. p. 208, Feb. 28, 1907.)—In this lamp, which is of the enclosed type, the upper carbon slides freely in a vertically movable cylinder that extends through the series-wound regulating solenoid where it is provided with a tubular jacket forming the core of the solenoid. The cylinder bears at its lower end a piston moving in a dash-pot cylinder, and on the underside of the piston are pivotally mounted three spring-controlled clutch-levers which normally hold fast the upper carbon, but which release the carbon when the cylinder is in its lowermost position, this being effected by the pressure of these clutch-levers against the bottom of the dash-pot cylinder. The cylinder is guided at the top by three radially arranged rollers and at the bottom by a porcelain bush. At 120 volts (24 volts of which are absorbed by the series resistance), the lamp gives 800 Hefner candles = 0·465 watts per Hefner candle; with an opal glass globe the c.p. fell to 356 Hefner candles = 1·026 watts per Hefner candle. The above are mean hemispherical c.p. C. K. F.

434. *Bevis and Angold's Magazine Inclined-Carbon Arc Lamp.* (Brit. Pat. 24,061A of 1905. Engineering, 83. p. 293, March 1, 1907. Abstract.) —In this lamp the carbons move parallel to each other down a sloping channel, in which they stand on their ends. At the bottom their further motion into the clutch-tube is arrested by a low wall or bar. When the carbon in the clutch-tube has burned away so as to move down past the transversely movable grip-block of the clutch, the clutch-lever moves so as to bring an extension-piece thereon through an aperture in the lower end of the sloping channel of the magazine and thereby lifts the lowermost carbon to the top of the low wall or bar, thus allowing it to be pushed on by the carbons behind it into the clutch-tube, down which it falls, whereupon the normal burning of the lamp is resumed. C. K. F.

435. *New Method of Operating Mercury Vapour Electric Apparatus.* (Brit. Pat. 13,418 of 1906. Engineer, 103. p. 358, April 5, 1907. Abstract.)—This invention, communicated by the General Electric Co. (U.S.A.), consists in including in the vapour tube a wire spiral of some refractory metal coated with a suitable oxide (of Ba, Ca, Th). At a red heat the spiral gives off negative ions or negative electricity. At starting, an auxiliary anode, placed near to this spiral, serves to facilitate this operation, but the active spiral is kept glowing all the time. When the apparatus is adjusted to take a small current, it is found that the operation apparently is not that of the ordinary mercury arc, no kathode spot being produced on the surface of the mercury. The current flow fills the tube with a brilliant illumination, taking place through the mercury vapour in the tube. The illumination is exactly like that of the mercury arc lamp, except that there is no flicker or pulsation in the light, owing to the absence of the kathode spot. By means of these negative ions,

which are emitted by the spiral at a relatively low temperature, the current is transferred through the mercury vapour without, it is stated, any considerable evaporation of mercury taking place. L. H. W.

436. *Brockie's Magazine Inclined-Carbon Arc Lamp.* (Brit. Pat. 11,961 of 1906. Engineering, 83. p. 298, March 1, 1907. Abstract.)—In this lamp there are two magazines *a*, *a'*, which are pivotally supported at their upper ends on the lamp-frame and have convergent guide-tubes *i*, *i'* for the carbons extending downwards from their lowermost corners. The remaining parts of the bottoms of the magazines are formed by movable plates *f*, *f'*, the inner ends of which are connected by links *g*, *g'* to the outer ends of centrally pivoted levers *h*, *h'*, and the inner ends of these levers are connected to the



core of the solenoid *c*, so that when the core falls the inner ends of the plates *f*, *f'* will be raised, thereby facilitating the sliding down of the carbons in the magazines towards the guide-tubes *i*, *i'*. The bodies of the magazines are connected to the core of the solenoid *c* by links *d*, *d'*, which are inclined in such a manner that when the core rises the lower ends of the carbons will be separated to strike the arc, and when the core falls the lower ends of the carbons will be brought together. The carbons are retained in position by contact-springs at the lower ends of the guide-tubes *i*, *i'*, and are fed downwards by bars *m*, *m'*, which act on them through longitudinal slots in the tubes *i*, *i'*. These bars are mounted on an endless travelling band *k*, which is driven by a motor whose operation is governed by the pressure of the arc. C. K. F.

437. *Ulbricht's Globe Photometer.* E. Winkler. (Schweiz. Elektrot. Zeit. 4. pp. 85–92, Feb. 28; 97–99, March 2; and pp. 110–118, March 9, 1907.) —After a brief mention of various forms of integrating photometer, the author studies in detail Ulbricht's Globe photometer. Following a method of treatment due to Presser [Abstract No. 461 (1907)], he develops the theory of this photometer in a simple manner, making use of very elementary methods, and

explains how the photometer may be standardised. A description is next given of an instrument of this kind constructed by the author, and specially intended for the measurement of arc-lamp intensities. The inner diam. of the globe is 2 m. The globe consists of two hemispheres, the dividing plane being horizontal. The lower hemisphere is fixed to the floor, while the upper one may be raised and run horizontally along rails provided for the purpose. By removing the upper hemisphere the mean hemispherical c.p. of an arc lamp may be determined. At the top of the upper hemisphere is a circular opening about 50 cm. in diam., through which the lamp to be tested may be lowered into the globe. At the bottom of the lower hemisphere a circular opening about 25 cm. in diam. is provided, which enables any ashes or carbon dust which may drop down from a naked arc to be removed. The hemispheres are built up of numerous segments, and strengthened on the outside by means of T-irons. Along two meridians of the globe are provided, at intervals of every 10°, circular observation windows 5 cm. in diam., which may be closed by sheet-iron slides. When using any observation window the slide is withdrawn, and for it substituted a plate of milk-glass. The inner surface of the globe was first thickly coated with white enamel so as to obtain a smooth surface, and was then given a double coating of zinc-white mixed with unboiled milk. This method of treatment yielded most satisfactory results, the surface being perfectly uniform, fine-grained, matt, white, and preserving its colour. Lime-water is not to be recommended as a binding medium for the zinc-white, as it causes a yellow discoloration in course of time; while oil colour is unsuitable as it yields a shiny surface giving regular reflection, to which the theory of the instrument is inapplicable. Accounts are given of various tests carried out on this instrument, which proved its reliability. The author strongly urges the great convenience, accuracy, and saving of time which result from the adoption of this form of photometer. [See also Abstracts Nos. 1160, 1688 (1905), and 772 (1906).] A. H.

438. *Instantaneous Photometric Values with Alternate Current.* J. **Sahulka.** (Elektrotechnik u. Maschinenbau, 25. p. 183, Feb. 17, 1907.)—The author describes an apparatus for determining the variation of light during a complete cycle of alternating current, similar to that mentioned by Morris [see Abstract No. 88 (1907)]. According to the author's modification, which was described by him in Vienna in Nov., 1906, two parallel plates, provided with slits, are mounted on the spindle of a synchronous motor, the photometer being between the plates. In this way both the curve and the actual values of the light can be determined. At the same time contacts are mounted on the pulley for determining the curve showing the shape of the current wave and the voltage. In this way the connection can be shown between the instantaneous values of the light and current. W. H. S.

439. *Instantaneous Values of Electric Lights on Alternate Current.* J. **Sahulka.** (Elektrotechnik u. Maschinenbau, 25. pp. 213–217, March 17, 1907. From the elektrot. Inst. der k.k. techn. Hochschule, Wien.)—With further reference to the matters described in the preceding Abstract, the author states that he has determined the resistance-curve of an alternate-current lamp by inserting a Joubert contact, driven by a synchronous motor, in the galvanometer circuit of a Wheatstone bridge. By gradually shifting the brush on the contact disc the curve can be plotted out. At the same time the current-curve can be determined by putting the galvanometer circuit in shunt with that arm of the bridge which is in series with the lamp. In this

way a series of readings is obtained proportional to the voltage across this arm, and therefore to the current flowing through the lamp. A table is given of results obtained with an "osmin" lamp, from which it appears that the resistance varies 2·1 per cent. on either side of the mean, and the c.p. similarly varies by 23 per cent. The lamp in question gave 58·9 Hefner c.p. on 110 volts direct current, taking 58·2 watts; it was run on alternate current at 116·5 volts with a periodicity of 50, and the light-values were determined by interpolation from a curve prepared by running it at different pressures on direct current. Curves are given as a graphical interpretation of the results obtained. A further description is also given of the author's apparatus, already described [*loc. cit.*], for the determination of the light-values by means of radial slits in a disc mounted on the spindle of a motor. But results obtained by this method are said to be inexact, partly owing to the fact that the breadth of the slits must be sufficient to allow a measurable amount of light to pass. However, with arc lamps there is no difficulty. W. H. S.

440. *New Incandescent Lamps.* J. **Swinburne.** (Inst. Elect. Engin. Journ. 38. pp. 211–226; Discussion, pp. 226–266, April, 1907. Electrician, 58. pp. 520–523; Discussion, pp. 523–524, Jan. 18, and pp. 564–565, Jan. 25, 1907. Abstract.)—Inventors have had to experiment with new chemical processes for obtaining pure metal in a form suitable for making into fine enough wire to meet the requirements of specific resistance and practical voltage. The author reviews the possibilities of the various groups and series of metals according to the Periodic Law, and gives curves showing the relation of atomic weight with fusing point, atomic volume, and conductivity. The possible methods of manufacturing filaments are described. Alloying usually increases the specific resistance, but at the same time has the disadvantage of reducing the melting-point and temperature-coefficient. Comparison is made between the Nernst and metallic lamps. Tantalum possesses a specific resistance of 16·5 microhms cold and 85 at the working temperature of the lamp; it is drawn into wires 0·035 mm. diam. for the 25-c.p. 110-volt lamps, 20,000 of which are made from 1 lb. of the metal. Tantalum is melted in the electric arc, the ingots hammered into sheets, and the latter drawn into wire. Osmium and tungsten lamps are very promising, but cannot at present be made for 100 volts in the smaller candle-powers. In the *discussion*, **J. A. Harker** exhibited a table of fusing points of the elements grouped according to the Periodic Law. **G. Kapp** stated that a rise and fall of 4 per cent. in voltage resulted in an increase of 25 per cent. and decrease of 20 per cent. of light in carbon lamps, 18 per cent. and 12 per cent. in tantalum lamps, and 22 per cent. and 18 per cent. respectively in osmium lamps. He compared the temperature and c.p. of incandescent and Nernst lamps with results which would be expected according to Guilleaume's and Boltzmann and Stefan's laws. **S. P. Thompson** exhibited microscopically specimens of tantalum filaments to show the disjointed character which the filament acquires under alternating currents. **C. C. Paterson** exhibited life and efficiency curves of the new lamps. **J. A. Fleming** pointed out that metallic lamps have less tendency towards electronic discharge across the legs of the filament than carbon lamps, and he discussed the possible advantage in luminous efficiency of the metallic lamps on alternating currents due to the positive temperature-coefficients. **V. H. Mackinney** gave results of photometric and life tests on "Osmi" and tantalum lamps; the latter fall about 17 per cent. in efficiency after 1,000 hours, due to blackening, "Osmi" lamps remaining unblackened. The physiological effects of the various

colours of light were touched upon. **J. T. Morris** showed current and voltage curves for carbon, tantalum, "osram," and wolfram (tungsten) lamps. **L. Gaster** exhibited a 200-volt zircon-wolfram lamp taking about 1 watt per candle. **H. M. Sayers** showed photomicrographs of tantalum lamps from alternating circuits of various periodicities. H. F. H.

441. *A Titanium Lamp.* (Electrical World, 49. p. 394, Feb. 16, 1907. Electrician, 58. pp. 892–893, March 22, 1907. Écl. Électr. 50. pp. 434–435, March 28, 1907. Elec. Engineering, 1, p. 470, March 14, 1907.)—This is an abstract of a patent, granted to J. A. Heany, for the manufacture of titanium lamps (U.S. Pat. 842,546). It is very general in its scope, but the following may be taken as an illustration of the proposed method. Nitride of titanium is formed by heating the oxide in the presence of ammonia, and is then mixed with a small proportion of water or paraffin, and reduced to a state in which it can be squirted. The filament is heated, and under the influence of a high temperature, caused by the passage of an electric current in a vacuum, the nitride decomposes, and a filament of titanium is left. Other methods are described for obtaining a metallic filament from a very fine powder, or from the dioxide by reduction in hydrogen, and care is taken to prevent any admixture of carbon, seeing that the metal is said to be more refractory than the carbide. W. H. S.

442. *New Metallic Filament Lamps.* **O. Ely.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 389–390, March 9, 1907. Paper read before the Fränk.-Oberpfälz. Bezirksverein, Dec. 17, 1906.)—The author briefly deals with the zirconium and the tungsten lamp, and then refers to tests made at the town electricity works at Nuremberg, in which "osram" and tungsten lamps were run at twice the normal voltage. The 32-c.p. (Hefner) osram lamp for 115 volts gave, at 220 volts, 315 c.p., and showed a specific consumption of 0·32 watt per Hefner, whilst a tungsten lamp made by Lüdecke and Co., of 40 c.p. and 1·1 watts per Hefner, gave 510 c.p. at 220 volts with a specific consumption of 0·28 watt per Hefner. A 16-c.p. carbon filament lamp was run at the double voltage (220) for comparison, and showed 250 c.p., or 0·88 watt per Hefner. L. H. W.

443. *Electric Lighting by Incandescence.* **W. J. Hammer.** (Elect. Rev., N.Y. 50. pp. 388–392, March 9, 1907. Elect. Engin. 39. pp. 438–441, March 29, 1907.)—The author first traces the historical evolution of the incandescent lamp, and with regard to the carbon filament lamp, points out that though its efficiency has been improved, no single basic feature has been eliminated from, and no absolutely essential feature added to the original first commercial lamp of 1879. The chances of the Nernst lamp and of the friable metallic filaments are then considered, and in this connection attention is drawn to the little-known early work of Lodyguine with refractory bodies deposited upon a platinum or carbon base, as well as to his molybdenum and his chromium filaments (U.S. Pats. 575,668, 575,002 respectively). Reference is made to the Heany titanium filament lamp [Abstract No. 441 (1907)], and to the fact that Waidner and Burgess, of the Washington Bureau of Standards, found that his tungsten lamps showed a temperature of 3,200° C. without blackening. The Moore tube and the mercury vapour lamp are also briefly referred to. L. H. W.

REFERENCES.

444. *Specifications for Track Material adopted by the German Street and Inter-urban Railway Association.* (Street Rly. Journ. 29. pp. 25–26, Jan. 5, 1907.)

445. *Diagram for Determining Voltage Drop in Transmission Lines.* **T. W. Varley.** (Electrical World, 49. pp. 301–302, Feb. 9, 1907.)—A simple diagram by means of which the reactance voltage per 1,000 ft. of wire may be at once read off for various cases. A. H.

446. *Statistics of Swiss Electricity Works for* 1905. (Jahrb. d. Schweiz. Elektrot. Vereins, 17. Part II. 1906–1907.)—The tables are given as before [Abstract No. 647 (1906)], but the analytical summary with classification is more complete.

447. *Travelling Transformer Substation for the Valtelina Railway.* **E. Cserháti.** (Elektrotechn. Zeitschr. 28. pp. 267–268, March 21, 1907.)—A transportable transformer substation, of 430 kv.a. capacity, consisting of a 3-phase transformer and the necessary switchgear contained in a car constructed entirely of iron, has since 1905 been in use on the Valtelina railway. The car may be anchored at any desired point on the line, and is intended to deal with the load at any substation undergoing repairs, or to prevent excessive drop at any particularly congested part of the line. A few illustrated particulars of the equipment of this transformer car are given by the author. A. H.

448. *Effect of Metallic Filament Lamps on Choice of Supply Voltage.* **E. Wikander.** (Elektrotechn. Zeitschr. 28. pp. 166 and 168, Feb. 21, 1907.)—It is well known that the voltage for which the new metallic filament lamps can be made does not exceed about 120. As a result of circularising a large number of central station engineers, it was found that a large majority were in favour of the adoption of a supply voltage of about 110. A. H.

449. *Power Plant and Equipment of the Long Island Railroad.* **W. N. Smith.** (Street Rly. Journ. 27. pp. 896–905, June 9; 936–945, June 16; 968–983, June 23, and 28. pp. 216–226, Aug. 11, and pp. 250–260, Aug. 18, 1906. Elect. Rev., N.Y. 48. pp. 567–578, April 14; 907–915, June 9; 1000–1007, June 23; 1029–1033, June 30, and 49. pp. 210–217, Aug. 11, 1906. Electrician, 57. pp. 806–810, Sept. 7, and pp. 851–853, Sept. 14, 1906. Abstract.)—Full illustrated descriptions of the power-house, transmission line, and third-rail system, as well as of the rotary converter substations and the car equipment. Three 5,500-kw., 3-phase, 11,000-volt Westinghouse-Parsons steam turbo-generators are at present installed. The under-running type of third-rail is used [Abstract No. 1444 (1905)]. L. H. W.

450. *Columbus, Ohio, Electric Railway System.* (Street Rly. Journ. 28. (Columbus Convention Section) pp. 592–690, Oct. 13, 1906.)—Practically every detail of the equipment and methods employed on the lines in and around Columbus is considered and illustrated. The total length of line (single track) is 106 miles. Most of the lines concerned have been dealt with separately.

451. *Thermit Rail-welding on the Utica and Mohawk Valley Railway.* **M. J. French.** (Street Rly. Journ. 29. pp. 59–61, Jan. 12, 1907.)—Information as to cost is given.

452. *Braking for Electric Cars.* **G. C. Graham.** (Street Rly. Journ. 28. pp. 475–476, Sept. 29, 1906. Paper read before the New York State Street Rly. Assoc.)—Deals with the methods employed in Buffalo.

453. *Different Systems of Brakes.* **H. S. Williams.** (Street Rly. Journ. 28. pp. 476–478, Sept. 29, 1906. Paper read before the New York State Street Rly. Assoc.)—Discusses the employment of the air brake and the electro-pneumatic system.

454. *Electrically-driven Cargo Steamer on the Lake of Geneva.* (Elektrotechnik u. Maschinenbau, 24. p. 1070, Dec. 30, 1906. From Schweiz. Bauzeitung, Sept. 29, 1906.)—A description of the Diesel-electric equipment of a small steamer of 125 tons carrying capacity. The Del Proposto system [Abstract No. 1155 (1906)] is employed.

455. *Seebach-Wettingen Locomotive.* (Elektrotechn. Zeitschr. 28. pp. 72–77, Jan. 24, 1907.)—Most of the details contained in this paper have already been described [Abstract No. 242 (1906)]. The induction regulator mode of control has been abandoned, and the method of varying the secondary turns is alone in use at present. The switch for varying the turns is actuated by a small induction motor. Curves are given for the power-factor at various voltages and speeds. The power-factor varies from about 0·5 to about 0·97. Complete wiring diagrams and drawings of the motors are given. A. H.

456. *Brakes for Tramcars.* **H. M. Sayers.** (Electrician, 57. p. 920, Sept. 28; 956–957, Oct. 5; 58. pp. 7–9, Oct. 19, and pp. 82–84, Nov. 2, 1906.)—Reviews the chief merits and disadvantages of the different types of brakes in general use. Fell's data are largely drawn upon [see Abstract No. 479 (1906)].

457. *Greenwich Power-house and the London County Council Tramways.* (Electrician, 56. pp. 743–745, Feb. 23; 789–792, March 2; 833–835, March 9; 877–881, March 16, and p. 930, March 23, 1906. Elektrotechnik u. Maschinenbau, 24. pp. 534–536, June 24, 1906. Street Rly. Journ. 28. pp. 19–23, July 7, 1906.)—Illustrated description of the new power-house and its equipment. For description of track and distributing system see Abstracts Nos. 1118, 1119 (1904), also 1467 (1905), and for Vauxhall Bridge-Victoria extension see Tram. Rly. World, 19. pp. 415–421, May 10, 1906; Victoria Embankment extension, Tram. Rly. World, 21. pp. 25–31, Jan. 10, 1907.

458. *Road and Rolling Stock of the London Underground Railways.* (Engineer, 102. pp. 174–175, Aug. 17, 1906.)—Deals with the Metropolitan and Metropolitan District Railways, the design of the carriages on the latter being severely criticised as regards bogies and bearing springs, buffer and draw arrangements, as well as noisy running. The peculiar and severe wear on the rails, due probably to the latter not having been properly bent to the radius of the curve where laid, is also referred to. L. H. W

459. *Electrical Automobiles.* **E. Sieg.** (Elektrotechn. Zeitschr. 27. pp. 1017–1021, Nov. 1, 1906.)—Reviews the present state of the industry with special reference to the electric cabs of the firm of G. Hagen [see Abstract No. 812 (1905)].

460. *The Tungsten Lamp.* (Electrical World, 48. pp. 394–396, Sept. 1, 1906.)—A summary of the published information relating to tungsten itself and its employment in glow-lamps. [See also Abstracts Nos. 871 and 886 (1906).]

461. *Theory of Ulbricht's Globe Photometer.* **E. Presser.** (Elektrot. Anzeiger 23. pp. 885–886, Sept. 2, and pp. 912–914, Sept. 9, 1906.)

462. *Application of Photometric Data to Indoor Illumination.* **E. C. White.** (Electrical World, 48. pp. 744–745; Discussion, pp. 745–746, Oct. 20, 1906. Abstract of paper read before the Illuminating Engin. Soc., Oct. 12, 1906.)—The paper is principally devoted to the explanation of a new form of polar diagram, representing the distances in all directions at which equal illumination is produced by the source from which the curve is plotted. The advantages of this form of curve are enumerated. As an example, a diagram of uniform illumination and candle-power distribution, obtained with a 16-c.p. lamp with pagoda reflectors is given. L. G.

TELEGRAPHY AND TELEPHONY.

463. *Experimental Study of Lines and Telegraphic Apparatus.* **Devaux-Charbonnel.** (Soc. Int. Élect., Bull. 7. pp. 171–198, March, 1907.)—Some of the investigations of the author were dealt with in Abstracts Nos. 1106 and 1107 (1906). Among others, in the present paper, is an account of experiments on mutual induction. The author separates the electrostatic from the electromagnetic action. To study the former, the intensity of the current is reduced as much as possible; one extremity of the inducing wire may be, for instance, insulated. On the contrary, in the case of the latter action, a current as strong as possible is employed, while maintaining the potential similar to that of the wire acted upon. The results obtained on a cable 9 km. long, paper-insulated, with copper conductor 2 mm. in diam., were as follows Electrostatic induction, 0·085 mfd. per km.; electromagnetic induction, 0·25 millihenry per km. The former, therefore, plays a much more important *rôle* than the latter. In ordinary practice, suppose a subterranean conductor, 10 km. in length, having a resistance of 50 ohms, transversed by a current of 50 milliamps., furnished by a battery of 100 volts. The quantities of electricity induced are: 2·5 microcoulombs for the electromagnetic induction, and 85 microcoulombs for the electrostatic induction. The latter is, therefore, 14 times as considerable as the former. To calculate the mean voltage which corresponds to the currents induced, it is necessary to hypothetically consider their duration. The capacity of an underground section of a circuit being very large by comparison with that of the aerial section, the former will be charged very rapidly. The phenomenon will be most marked at the beginning of the circuit. It will be complete at the end of $\frac{25}{1000000}$ of a sec. Assuming that this represents the deviation of the induced currents, their voltages will be respectively 2·5 and 85 volts. These induced currents are of short duration, and at the moment of transmission of a signal, they are superposed on the working current, become rapidly enfeebled, and do not, at the outset, sensibly modify the propagated signal in arriving at the distant end of the circuit. But if the receiver has small self-induction and resistance the induced current may be considerable, and may reach a strength of even 1 amp. With more self-induction in the receiver the strength will be less, but in any case, owing to this property and to the capacity of the cable, oscillations will be set up. The intensity is given by the formula—

$$I = E\sqrt{\frac{C}{L}}e^{-\frac{\delta}{2}}.$$

For the line considered above, with a Baudot receiver (L = 2, R = 200) the current might be 16 milliamps. When an oscillograph is employed to examine these effects it becomes apparent that a Morse instrument, with a larger self-induction, reduces the induced currents to a much greater extent than the Baudot. With apparatus of small self-induction and resistance it is, therefore, advisable not to leave the line free of current, or neutral, and to arrange that the current shall be superior to the induced disturbances.

E. O. W.

464. *The Baudot Telegraph System in India.* **C. T. Williams.** (Electrician, 58. pp. 881–883, March 22, 1907.)—This system was successfully installed in India in 1905. Calcutta could work to Simla, a distance of 1,240 miles, with translation at Allahabad, using an iron wire; with copper it was found possible to dispense with the translation. Madras to Bombay, 795 miles, and Calcutta to Madras, 1,000 miles, have also been equipped. On the iron-wire circuits communication was not good in the rainy season. But with the use of copper conductors there was complete success even at that time. It is proposed to establish the system between Calcutta and Rangoon, a distance of 1,000 miles. Over these great distances the author considers that the system is economical, the cost of the personnel required being less than the interest on the outlay for extra wires which would be necessary with slow-speed Morse working. E. O. W.

465. *Telegraphic Transmission of Photographs.* **A. Korn.** (Phys. Zeitschr. 8. pp. 118–120, Feb. 15, 1907. Electrician, 58. pp. 765–766, March 1, 1907. Translation.)—The author gives an account of the latest improvements introduced into his apparatus [Abstract No. 125 (1906)]. The main defects of the former arrangement were the comparatively slow speed of transmission, due to the inertia of the receiving galvanometer, and errors due to the sluggish action of the selenium cells. These defects have now been overcome by the adoption of the special light relay and the selenium compensator described in Abstract No. 107A (1907). A. H.

466. *Gott's Manganin Arm.* **A. R. Short.** (Electrician, 58. p. 816, March 8, 1907.)—In finding the position of a fault on a submarine cable by means of the Varley loop test, one of the arms of the bridge is sometimes made of manganin, so as to compensate automatically for the changes in the temperature of the coils in the test-room. In the ordinary method, however, of applying the test the compensation is not quite perfect. The author works out the formulæ, taking the effects of temperature into account, and, as they are complicated, suggests that it would be preferable to use a Wheatstone bridge made wholly of manganin. He also works out the corrections which have to be applied to the usual formulæ when an ordinary bridge is used. A. R.

467. *Detectors for Wireless Telegraphy.* **W. H. Eccles.** (Elect. Engineering, 1. pp. 241–246, Feb. 7, 1907.)—There are five classes of oscillation detectors. First, imperfect electrical contacts (coherers) between conductors which are made less imperfect by the action of the oscillations. Second, electrolytic detectors in which ordinary electrolytic processes are disturbed by oscillations. Third, magnetic detectors in which the magnetic condition of a ferromagnetic material is altered by the oscillations. Fourth, thermal detectors, which detect oscillatory currents by their heating effects. Fifth, a miscellaneous class containing those which cannot be put under any of the above heads. The above classes are roughly in the order of their present practical importance. The typical coherer consists of two conductors separated by a very thin layer of insulating fluid or one of a solid compound formed on the surface of one or both of the conductors. Carbon is self-decohering, but not so sensitive as metallic coherers. The most ingenious and probably most perfect form of two-conductor coherer is the Lodge-Muirhead wheel. A number of coherers, such as those of Branly, Maskelyne,

and Popoff-Ducretet, depend on the penetration of an oxide film between two conductors. The most widely used type of coherer is that made with metallic filings. Marconi has developed this to a high state of perfection, both as regards reliability and sensibility. It is an instrument which can be relied upon fully. The coherer's reputation for erratic behaviour is wholly due to bad workmanship. The Slaby-Arco coherer is very like Marconi's; its electrostatic capacity is said to be approximately equal to that of a wire 8¼ m. long and 1 mm. diam. suspended horizontally 1 m. above the ground. Among magnetic detectors Marconi's moving band instrument takes the leading place. From the author's experiments it would appear that such a detector should answer better with damped than with undamped vibrations; it is therefore difficult to account for its reputed superiority for syntonic work. Possibly, however, its superiority may arise from the constancy of its electrical dimensions. The ideal detector, in which the oscillations would set a-going some process which, summing up molecular forces, would produce a much greater display of energy than that due to the oscillations, does not yet exist. Something of the nature of a wattmeter, which would continuously record the state of the oscillatory currents, would appear to be the type of instrument which in the future should prove of most value.

J. E.-M.

468. *Arc* v. *Spark in Wireless Telegraphy.* **L. H. Walter.** (Elect. Engineering, 1. pp. 252–254, Feb. 7, 1907. Elect. Rev., N.Y. 50. p. 358, March 2, 1907. Abstract.)—The author pointed out some time ago that the development of wireless telegraphy depended largely on the improvement of the transmitter. The recent inventions of Poulsen, S. G. Brown, Vreeland, and others are all in this direction, and supply means for maintaining the uniform succession of oscillations which is so desirable for syntonic working. In the author's view Elihu Thomson's method, though claimed to be an arc method, seems to depend on an acceleration of the spark discharges. The remarkable results attained by Poulsen with the arc have led to much interest being taken in the problem. S. G. Brown's method must, it is thought, apparently be classed as an arc method, since the working conditions appear to be similar. The advantages of the arc method of transmission are, for some purposes, counterbalanced by the increased weight and complication of the apparatus necessary for its use. The figures given by Poulsen for the efficiency of the arc as a transmitter indicate a rapid decrease of efficiency with increasing frequency. More definite information is much wanted on this point. The transmitter arrangements of Eisenstein and of Sahulka for increasing the frequency of sparking are described [see Abstract No. 225 (1907)].

J. E.-M.

469. *Wireless Telegraph Masts.* **G. H. Barbour.** (Electrical World, 49. pp. 437–441, March 2, 1907.)—The author describes the various types of wireless telegraph masts which he has erected during the last few years. These may be divided into four classes. The first is the shipmast type, now practically obsolete on account of its unsymmetrical resistance to side strains, and the difficulties of erection. The second is a light trellis-work tower whose diameter may be about one-tenth of its height or somewhat less. It has the advantages of greater stability, though it must be guyed to resist wind, and is very easily built up *in situ.* The third form is in reality a girder, formed from wood, and built before erection; the section is much

less in area than that of the second form, and the whole mast much lighter. It consists of four corner-posts braced together at intervals throughout their lengths by means of square filler blocks to which the longitudinal pieces are bolted. The size of the timbers from which the corner-posts are built up may be 25 ft. × 8 in. × 8 in. The fourth class is a mast built from end to end of pieces of thick planking, say 2 in. × 8 in., in sections bolted together. It is very flexible, very light, and resists wind pressure exceedingly well. Examples are to be found at Oxford and Cambridge. The construction and erection of such a mast may be done in two or three weeks. The actual raising of the mast, which is lifted in one piece by means of a jury mast at right angles to it, takes about one day. J. E.-M.

REFERENCES.

470. *Wireless Telegraph Receivers.* **S. M. Kintner.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 65–71, Jan., 1907.)—A few typical receivers, mostly of Fessenden's design, are briefly discussed, including the so-called suspended ring galvanometer. L. H. W.

471. *Telephone Dictating Apparatus.* (West. Electn. 40. p. 281, March 16, 1907.)—This describes a convenient arrangement for dictation to stenographers by the aid of an "acoustican" transmitter and "loud earpiece" receivers, patented by Turner and Germer in the U.S.A. E. O. W.

472. *Measurement of the Constants of Telephone Lines.* **B. Gáti.** (Electrician, 58. pp. 81–82, Nov. 2, 1906.)—The three-barretter method of measuring power [see Abstract No. 1436A (1906)] is here applied to the case of an unloaded cable 8 km. in length. L. H. W.

473. *Multiple Telephone Switchboards for Nürnberg and Fürth.* **J. Jacob.** (Elektrotechn. Zeitschr. 28. pp. 145–150, Feb. 14, and pp. 172–177, Feb. 21, 1907.)—A very complete description of the new Central Battery installations by Siemens and Halske, with diagrams. E. O. W.

474. *Underground Telephone Systems in Bavaria.* **W. Schreiber.** (Elektrotechn. Zeitschr. 27. pp. 1158–1162, Dec. 13, and pp. 1179–1184, Dec. 20, 1906.)—A complete account of the estimated cost of an underground system, of the necessary junction and distribution boxes, and the most economical sizes of cables, as well as the mode of providing house services. The boxes are fully illustrated and described. The underground system has been adopted in all large Government installations since 1904, and has given satisfaction. E. O. W.

475. *The Simplon Telegraph and Telephone Cable.* **G. Di Pirro.** (Journ. Télégraph. 31. pp. 4–8, Jan. 25, and pp. 25–29, Feb. 25, 1907.)—The construction of the cable was described in Abstract No. 1109 (1906). The present paper contains mathematical determinations of the capacity, inductance, and constant of attenuation, and also the means of testing the two first properties. Reference should be made to the paper, which is not suitable for abstracting. E. O. W.

476. *Adaption of the Slide Rule for use in Wireless Telegraphy Calculations.* **J. Goodman.** (Electrician, 58. pp. 962–963, April 5, 1907.)

SCIENCE ABSTRACTS.

Section B.—ELECTRICAL ENGINEERING.

MAY 1907.

STEAM PLANT, GAS AND OIL ENGINES.

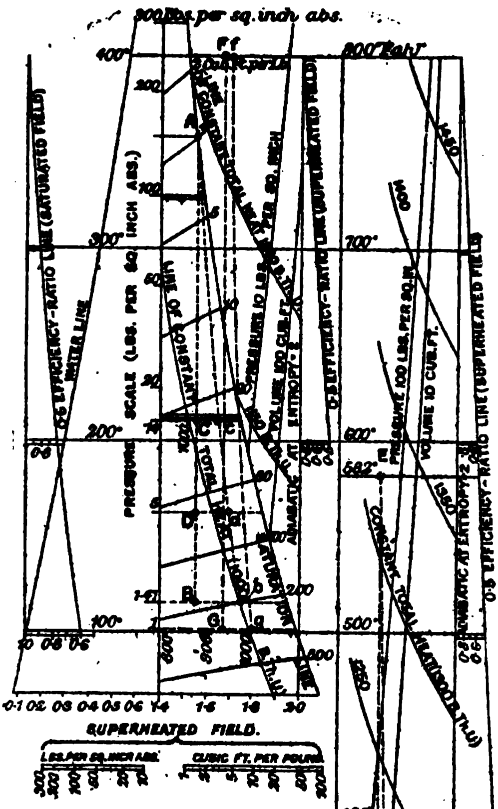
STEAM PLANT.

477. *Brush-Parsons Steam Turbine.* (Power, 27. pp. 20E–21E, April, 1907.)—The special features of this turbine, which is manufactured by the Brush Electrical Engineering Co., consist of constructional details which result in a considerable saving in length and other dimensions with increased accessibility. Sectional illustrations of a 1,000-kw. turbine are given. The bed contains tank, strainer, and cooler for the oil and the pipes for feed and return to the bearings, so that the casing is not encumbered with outside pipes. The principal novelty is a water-sealed gland on the main spindle, in which a rotating ring of water envelops the outside periphery of a fixed diaphragm and adjusts itself to existing conditions of pressure or vacuum. The use of this gland enables the rotor to be shortened and permits the shaft to be made stiffer at these portions concerned, besides exerting a cooling action on the shaft. F. J. R.

478. *Brown-Boveri New Steam Turbine.* (Mech. Eng. 19. p. 504, April 13, 1907.)—The low-pressure portion of multiple-step pressure turbines is divided into two groups of blades, the steam from the high-pressure portion flowing into one group directly and into the other in the opposite direction by means of openings into the interior of the drum, and thence round the low-pressure end thereof. The two low-pressure portions balance each other, and a dummy piston is required only at the high-pressure end, both high- and low-pressure parts of the turbine being mounted on the same shaft. With a comparatively high speed of rotation longer high-pressure blades may be used without an excessive length of low-pressure blades and the advantage of smaller ratio of clearance to blade-length secured in the high-pressure part. F. J. R.

479. *Energy Chart for proportioning Steam Turbines.* (Amer. Soc. Mech. Engin., Proc. 28. pp. 1221–1224, March, 1907. Discussion. Engineering, 83. p. 57, Jan. 11, 1907. Zeitschr. ges. Turbinenwesen, 4. pp. 160–161, April 10, 1907.)—[For H. Holzwarth's paper see Abstract No. 103, also No. 235 (1907).] Referring to Holzwarth's use of graphic methods of

representing steam turbine characteristics **H. R. Sankey** contributes his energy chart, represented diagrammatically in the accompanying Fig. It consists essentially of a temperature entropy diagram, on which, along a vertical line, is arranged a scale of pressures and temperatures. The right-hand portion of the Fig. is a continuation of the superheated field of the main diagram up to a temperature of 800° F. On the chart are drawn curves of constant total heat, and also lines of constant volume. The line



ENERGY-CHART
ARRANGED FOR USE WITH
TURBINES.

AB is drawn adiabatically, and is the expansion line of the Rankine engine. B is the exhaust point at a pressure of 0·1 atmo., or about 1·5 lb. per sq. in. The total heat at A is 1,192 B.Th.U., and at B is 890 B.Th.U. Hence the Rankine engine converts 302 B.Th.U. into work per lb. of steam. The application of the chart to two examples is explained, and the method of ascertaining the feed-water per h.p.-hour is also shown. F. J. R.

480. *Static Deflection of Turbine Rotors.* **R. H. Collingham.** (Engineer, 103. pp. 305–306, March 29, 1907.)—The author describes a graphical method of determining the deflection of any body of varying section, such as a turbine rotor. The method is an interpretation in graphical form of the fundamental differential $d^2y/dx^2 = M/EI$, where M is the bending moment at any point in

a beam, E is Young's modulus, and I the moment of inertia of cross-section of the beam. y is the deflection at any point, and x is the distance along the beam from either support at which the deflection y is measured. Integrating this fundamental equation twice gives the following relation for the deflection y: $-yE = \int\int(M/I)d^2x + cx + C$. A simple case of a loaded beam is first considered. The bending moment diagram is plotted, and from this a curve for

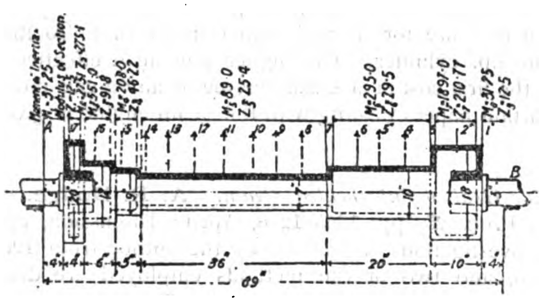


FIG. 1.

M/I, the moment of inertia I of the section being calculable. The latter curve is integrated graphically giving a curve representing $\int(M/I)dx$, which is termed the slope curve. The area of the slope curve up to any point represents the value of $\int\int(M/I)d^2x$, and dividing this area, which may also be obtained graphically, by E, Young's modulus, gives the deflection y at that point. In this way a deflection curve for the beam may be drawn. For a case considered the graphical method gave a result of 0·00129 in. deflection

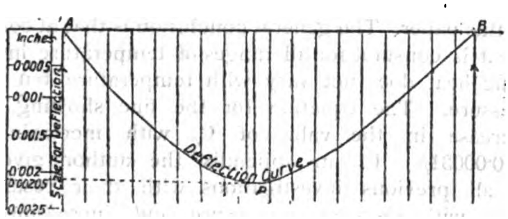


FIG. 2.

at the centre of a beam against 0·0018 by mathematical calculations. The method is then applied to the case of a Parsons turbine rotor. The curves mentioned above are plotted from tabulated results of the calculations. The deflection curve and the curves employed in deriving it are given in Figs. 1 and 2. The rotor is designed of cast steel having a modulus of elasticity of 30×10^6 lbs. per sq. in. The maximum deflection is 0·00205 in., which is very near observed practical results. A. G. E.

481. *Most Economical Mean Effective Pressure for Steam Engines.* **R. Royds.** (Inst. Engin. and Shipbuilders, Trans. 50. 6. (pp. 38–46) 1906–1907. Mech. Eng. 19. pp. 638–637, May 4, and pp. 670–672, May 11, 1907.)—In order to arrive at reliable data for a general conclusion as to the best mean pressure for steam engines, the author compares curves obtained from trials of various engines as published by Willans, Morcom, Weighton, Mellanby, and Longridge, and also some results obtained by Donkin and Ripper [see Abstract No. 895 (1906)]. The general effect is to show that there is a considerable range of mean effective pressure with little variation

in economy, the economical range being less for condensing than for non-condensing engines, and that the best or most economical mean pressure is higher for the non-condensing than for the condensing engine. Superheating, where the steam is superheated during expansion, considerably lowers the best mean effective pressure, and jacketing produces a similar result to a less degree. For multiple-expansion unjacketed condensing engines using saturated steam at about 165 lbs. per sq. in. abs. in the cylinder, the best mean effective pressure for normal load is from 40 to 45 lbs. per sq. in. referred to the l.p. cylinder. The higher the mean effective pressure the lower will be the first cost of a steam engine of any given power. A list of the most important papers dealing with the steam engine is given at the end of the paper. F. J. R.

482. *Specific Heat of Superheated Steam.* **A. R. Dodge.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 1265–1278, April; Discussion, pp. 1473–1477, May, 1907.)—Investigations carried on by the author from 1901 until now are referred to, and two of the methods employed are described, with diagrammatic illustrations of the apparatus. These methods are (*a*) the water injection method, using large quantities of superheated steam, averaging 10,000 lbs. of steam per hour, which is reduced to a lower superheat by injecting water; and (*b*) the throttling calorimeter method, employing superheated steam in both high- and low-pressure chambers of the calorimeter. Plotted curves are given of steam flow through calorimeter at different pressures; percentage increase of specific heat (C_p) with abs. pressure from 15 lbs. abs.; variations of C_p with abs. pressure taking $C_p = 0{\cdot}48$ at 15 lbs. abs.; water injection tests, with a complete chart of test No. 16, and an entropy diagram assuming values of C_p as determined in this paper. The general conclusion is that at constant pressure the specific heat is constant for all ranges of temperature investigated, and that the specific heat does not vary with temperature but increases with increasing pressure. The equation for the line showing approximately the same increase in the value of C_p with increasing pressure is $C_p = 0{\cdot}4754 + 0{\cdot}00031p$. In an appendix the author gives a table of references to all previous investigations with their results as regards variation of C_p with increasing pressure and increasing temperature, showing considerable divergence although the majority agree that C_p increases as the pressure increases. [See also Abstracts Nos. 1748, 2110, 2451, 2705 (1904), 374, 1608A (1905), 188, 828A (1906), 358 (1907).] F. J. R.

483. *Boiler Scale in Relation to Heat Transmission.* **E. C. Schmidt.** (Eng. News, 57. pp. 373–374, April 4, 1907. Abstract of paper read before the Western Rly. Club, Chicago.)—Tubes, which had been in service in locomotive boilers in various parts of the country and had scale of different characteristics formed upon them, were removed and placed in the experimental apparatus, which was a long water chamber through which the tube passed, and a combustion chamber connected to one end of the tube. Gas and air for combustion were supplied at constant pressure to the burner, and approximately at the same rate in all tests. The heat abstracted from the tube was determined by weighing the water which flowed through the chamber during the test and noting its rise in temperature. Under the conditions of the experiments, which were not conclusive, scale varying in thickness up to ⅛ in. causes loss of heat in transmission varying in individual cases from insignificant amounts up to 10 to 12 per cent. The loss increases

with the thickness, and is more affected by the mechanical structure of the scale than by thickness merely. Chemical composition, except in so far as it affects the structure of the scale, has no direct influence on its heat-transmitting qualities. F. J. R.

484. *Corrosion of Steel Boiler Tubes on Vessels fitted with Turbine Engines.* **J. E. Palmer.** (Eng. News, 57. p. 426, April 18, 1907. From Amer. Soc. Naval Engineers, Journ.)—The Shelby seamless steel tubes (about $\frac{1}{10}$ in. thick) in the Mosher boilers fitted on the steam yacht *Tarantula,* equipped with Parsons steam turbines, pitted badly and gave out in many instances within two months' service. Analysis of the boiler residues showed the presence of considerable amounts of copper. The origin of this copper was traced to the bronze blades of the turbine rotor. The blades themselves were found to be eroded and the deposit between blades showed 2¼ per cent. Cu, and, later, in the mud drum of one boiler 8·6 per cent. Cu. It is pointed out that the boiler water or additions had contained organic matter, which may have increased the action of the steam on the bronze. The use of another material for the blades has been suggested as the best means of overcoming this danger, or the placing of iron or steel turnings in the hotwell or at some point between the turbines and the boiler. L. H. W.

485. *Commercial Aspects of Oil Fuel.* **F. E. Junge.** (Power, 27. pp. 137–140, March, 1907.)—Heat density, or quantity of heat contained in unit volume, is of special importance in view of transportation or storage. Monetary value gives solid fuels the first place.

Thermal Value, Heat Density, and Heat Cost of Fuels compared.

	Combustible Gases.				Fuel Oils.				Solid Fuels.			
	Illuminating Gas.	Oil Gas.	Producer Gas.	Blast-furnace Gas.	Petroleum.	Crude Oil.	Gasolene.	Alcohol 90 vol. per cent.	Hard Coal.	Lignite.	Gas Coke.	Wood.
Heating value, cals. per kg.	9,700	9,900	1,080	780	10,500	10,080	11,000	5,600	6,500	3,000	7,000	2,800
Heat density (petroleum = 1·0) ...	0·06	0·11	0·019	0·011	100	99	90	56·8	62	25	37·5	11
Heat units (kg.-cals.) for 1 cent	1,764	1,344	—	—	1,785	4,158	1,659	1,306	10,794	18,270	8,400	4,536

Economic considerations show that products more valuable than the crude fuel may be obtained by treatment. Instances of this are given. The technical value of oil *versus* alcohol is discussed, and the comparative value of energine and ergin is alluded to. The latter is a new product from tar introduced in Germany, where it is prepared by a secret process. It has a heat value of 16,500 B.Th.U. per lb., and stands a high compression without premature ignition in engine cylinders. F. J. R.

486. *Heat required to keep a partially submerged Metallic Surface free from Ice.* **A. E. Freeman.** (Eng. Record, 55. pp. 369–370, March 16, 1907.)—The experiments were designed to cover conditions met with in hollow lock-gates of boiler-plate. Two concentric tanks were suspended from a wooden

stage, with means of submerging to any desired depth, in the water of a dam between the upper and lower Mystic Lakes at Winchester, Mass., about 80 ft. from shore and in about 85 ft. of water. (1) The annular space contained air heated by radiating coils. (2) The space was filled with water up to lake level and heated by the radiating coils. (3) The water in the space was heated by a perforated coil at the bottom. Radiation from the inside of inner tank was prevented. About fifteen tests of 2 to 4 hours' duration were made, and it appeared that with water as the conducting medium, from 28 to 30 B.Th.U. were transmitted per sq. ft. of exposed surface per degree F. per hour difference of temperature between plates and water. With air the heat transmitted was from 2¼ to 3 B.Th.U. The former freed the tank to a distance of 3 to 4 inches from the ice, the latter only a slight distance. F. J. R.

487. *Coal Purchase based on Calorific Test.* (Eng. Record, 55. pp. 487–488, April 6, 1907. Electrical World, 49. p. 670, April 6, 1907.)—Some years ago the United States Treasury Department put into effect a system of purchasing coal upon the heat-unit basis for the electric plants under its charge, the quality of the coal delivered under such contract being determined by proximate analysis and calorimetric tests. Similar methods of purchase are in use in the U.S.A. by the Interborough Rapid Transit Co. of New York, the Fuel Engineering Co. of Chicago, the United Gas Improvement Co. of Philadelphia, and other large Corporations. The success of this system of purchase has been so marked that Congress this year has authorised the Fuel-testing Division of the Geological Survey to determine the quality of coal purchased by all the Government Departments, and a general specification has been prepared to cover all purchases of coal with the exception of that required for the Navy. It is probable that half of the Government Departments will adopt this specification for their coal purchases during the coming fiscal year. In all cases where practicable the coal will be sampled during its discharge into the building where it is to be used. The sample selected will in no case be less than 100 lbs., and this will be reduced by repeated crushings and quarterings to the small amount required for testing by the Treasury Dept. The method of analysis and of calorific valuation will be that drawn up by the American Chemical Society. Payment will be made upon the basis of the price named in the proposal for the coal specified by the seller, correction being made for the variation in ash and heating value. For example, if the coal contains 2 per cent. more or less B.Th.U. than the standard named in the specification, the price will be increased or decreased in the same proportion. The price will also be further corrected for the percentage of ash, and for all coal which contains *less ash* than the standard named in the specification, a premium of 1 per cent. per ton *for each* 1 *per cent. of ash* will be paid. An increase of 2 per cent. of ash over the standard named in the specification, on the other hand, will not be weighted with a penalty; but above this limit a deduction will be made from the price paid for the coal, upon a basis set forth in the table accompanying the original article. The coal is to be weighed as delivered, and as payment is made upon this delivery weight the calorific test is made upon the coal containing whatever moisture may be present at the time. J. B. C. K.

488. *Feed-water Heater Dimensions.* **N. A. Carle.** (Power, 27. pp. 140 and 141, March, 1907.)—A chart for determining size of steam and water openings for different velocities of flow, and the necessary amount of steam for heating a given quantity of water through a desired range of temperature

under some different conditions of the heating steam accompanies this paper. The maximum quantity of heat per lb. of steam available for heating is taken as that from steam of 5 lbs. per sq. in. back pressure, the temperature of the condensed water leaving the heater being taken at 100° F., and the heat-transfer efficiency of the apparatus at 100 per cent.; the minimum being reckoned for steam of atmospheric pressure, drip water at 212° F. and heat-transfer efficiency 85 per cent. A value half-way between these two is indicated by a line as representing average conditions. Curves for steam velocities of from 4,000 to 10,000 ft. per min., and for water velocities of 150, 200 and 250 ft. per min. are given, and lines for rise of temperature of from 50° to 180°, advancing by 10°. Vertical scales give lbs. of water and lbs. of steam per hour, and horizontal scales give sizes of openings and total B.Th.U.

F. J. R.

489. *Alloys for Wear and Antifriction.* (Fr. Pats. 368,870 and 368,871.)—The former of these patents, the invention of P. I. Juppont and J. Teil, claims an alloy having high abrasion-resisting properties; its percentage composition is as follows, the limits being shown in brackets: German silver, 50 (40 to 70); Zn, 40 (20 to 55); Sb, 5 (2 to 15); Sn, 5 (2 to 20). The second patent refers to "grey metal," for bearings, &c., having the composition: Cu, 1·2 (0·4 to 1·25); Sn, 12 (10 to 15); Pb, 0·8 (0·6 to 0·85); Sb, 14 (6 to 20); Al, 35 (15 to 35); Zn, 37 (30 to 55). F. R.

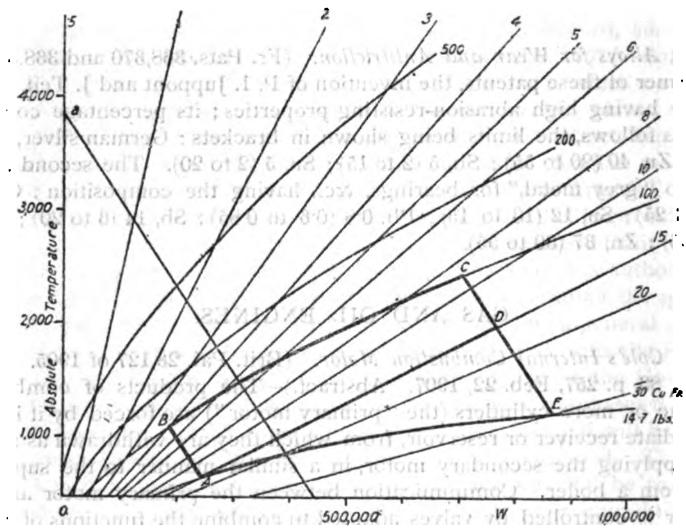
GAS AND OIL ENGINES.

490. *Cole's Internal Combustion Motor.* (Brit. Pat. 28,127 of 1905. Engineering, 83. p. 257, Feb. 22, 1907. Abstract.)—The products of combustion from one or more cylinders (the "primary motor") are forced by it into an intermediate receiver or reservoir, from which they are withdrawn as motive fluid supplying the secondary motor, in a similar manner to the supply of steam from a boiler. Communication between the primary motor and the reservoir is controlled by valves adapted to combine the functions of a non-return valve with those of the positively operated exhaust valve of the usual type in internal combustion engines. An elevation partly in section illustrates one form of this motor, which is due to T. H. Cole. F. J. R.

491. *Improvements in Gas-engine Ignition.* **J. R. Bibbins.** (Elect. Journ. 4. pp. 156–159, March, 1907. From the "Michigan Technic.")—To enable engines to work satisfactorily with different qualities of gas—as from some gas producers—it should be possible to alter the ignition-point while the engine is running, and the author has done this by using a spirally cut trip surface on igniter cams with a means of moving them along the driving-shaft so that the moment of release of the igniter can be varied to a definite degree. An illustration of this device as applied to three igniters of a Westinghouse gas engine is given, with a series of diagrams showing how the B.Th.U. consumption per hour varies with the degree of valve-opening and varying ignition-point in the case of an engine with two 9 by 11-in. cylinders, running at a constant speed of 300 r.p.m., at constant load of 70 b.h.p., with constant quality of gas (984 B.Th.U. per cub. ft.). The extreme limits of ignition were 0° early, or dead centre, and 55° early. The most favourable ignition-point appeared from all the diagrams to be from 30 to 35° early.

F. J. R.

492. *New Gas-engine Diagrams.* **F. Foster.** (Engineer, 103. pp. 181–182, Feb. 22, 1907.)—The construction and use of the work diagram suggested in Engineer, Dec. 1, 1905, by the author [see also Abstracts Nos. 245 and 246 (1907)] is here described and applied to reciprocating gas and air engines; and a new temperature-pressure diagram of similar construction for general gas-engine problems is shown. From pv calculations it appears that with a fixed value for the smaller volume v_1, lines of constant volume v_2 will be straight and pass through the origin of absolute temperature. The work diagram has temperature, and other quantities, measured along the vertical axis, and amounts of work along the horizonal axis. Constant-pressure lines are curved, bending away from the temperature axis, and are easily drawn



because the temperature at which a given constant-pressure line crosses a certain volume line is readily calculable. All adiabatics are straight and parallel, cutting the p and v lines transversely at an inclination of 181·4 of W. per deg. of temperature, as illustrated by the adiabatic a in the Fig. Tables to assist in the calculations for the drawing of the constant-pressure and constant-volume lines are given, and also a table of ratios of T_1 to T_2, and one for the construction of adiabatic lines or curves in the pressure-temperature diagram. In this diagram the absolute pressure is measured along the horizontal axis and the absolute temperature along the vertical. The constant-volume lines are straight lines passing through the origin of absolute temperature. Parallel with the pressure scale there can be placed a scale (for some convenient temperature T) of work done during isothermal expansion. The relation between temperature and pressure is given by $T = Cmp'^{-m}/R$, where $m = 1/n$. F. J. R.

493. *Tests of Producer-gas Engine.* **G. W. Bissell.** (Power, 27. p. 168, March, 1907. Paper read before the Amer. Assoc. for Advancement of Science.)—The load curves are given for this engine, which was a 8-cylinder

vertical single-acting, rated at 150 b.h.p., with cylinders 15 by 18 in. and speed 250 r.p.m. The producer was of the suction type. The engine was belted to a 75-kw. two-phase generator and exciter, but for these tests was run with a Prony brake. Three tests gave the following results :—

Tests.	Duration, Hours.	Average b.h.p.	Per cent. of Rating.	Coal as fired per b.h.p.	Total Efficiency from Coal.
I.	6	40·1	26·8	1·51 lb.	15·69
II.	7	82·5	55·0	1·15 „	17·56
III.	6	156·9	104·2	0·99 „	19·69

The heat balance from No. III. test at full load is as follows :—

		%			%
B.Th.U. in coal as fired	12,143,500	100	B.Th.U. in radiation from scrubber	39,000	0·31
			„ in vapouriser	79,000	0·65
„ in b.h.p.	2,391,524	19·69	„ in scrubber water	887,000	7·15
„ in unburned coal in ash	1,382,000	11·46	„ in jacket water	2,539,000	20·9
„ in radiation from producer.....................	285,000	2·33	„ in exhaust gases	3,856,000	31·75
			„ unaccounted for	674,976	5·55

F. J. R.

494. *Practical Data from Modern Gas Engines.* L. L. **Brewer.** (Power, 27. pp. 223–224, April, 1907.)—The author gives results of an investigation by a committee of American engineers into the working of European (principally Belgian and German) gas engines of sizes from 100 to 1,400 h.p., the information comprising weights of engines and flywheels, floor space, consumption of blast-furnace gas, water, and oil, and efficiencies realised. The weights and dimensions are given in a table embracing 19 engines of various sizes, which shows considerable economy in floor space per b.h.p. for the larger sizes. The statistics show that under German conditions at normal load a consumption of 106 cub. ft. of blast-furnace gas per b.h.p.-hour is usual. This is reckoned as equivalent to from 120 to 125 cub. ft. under American conditions, increasing with under-load up to 200 cub. ft. at ¼ load. The consumption of oil for lubrication and of cooling water shows for two-cycle and double-acting engines at about 0·0085 pint of oil and about 10 galls. of water per b.h.p-hour. The single-acting engines of the Cockerill type require considerably more. Mechanical efficiency shows for 2-cycle engines, single-acting with one cylinder, 78 to 82 per cent., and for double-acting with one cylinder, 70 to 75 per cent., and rather higher efficiencies for four-cycle engines. Thermal efficiency is not stated in percentage, but steam engines with gas-fired boilers are compared with gas engines as regards total consumption of gas, and show over-all economies of from 50 per cent at 100 h.p. to 75 per cent. at 750 h.p. The heat consumption of gas engines has been reduced to 9,000 B.Th.U. per b.h.p.-hour, and even less. F. J. R.

495. *Producer-gas Power Plant.* (Amer. Soc. Mech. Engin., Proc. 28. pp. 1297–1301, April, 1907. Discussion.)—[For J. R. Bibbins' paper see Abstract No. 249 (1907)]. Replying to the *discussion*, the **Author** gives additional data showing improvement in results from the Gould plant due to increased loading and more careful manipulation. Total fuel per kw.-hour 1·88 lbs.; plant efficiency (running), max. 16·6, min. 12·9, average 14·5 per cent.,

or including extra fuel for new fires 18·4 per cent. The rise in efficiency is shown as follows :—

Station loading factor...............	50	75	100 per cent.
Coal per kw.-hour	2·1	1·85	1·68 lbs.
Plant efficiency	11·7	18·6	15·2 per cent.

Repairs, which were only estimated in costs given in the original paper, are here stated to check closely with the estimate, but that the labour cost is not likely to be increased even were the plant doubled in capacity. F. J. R.

496. *Effect of Character of the Spark on Power developed by Petrol Engines.* **W. Watson.** (Automobile Club Journ. 18. pp. 207–210; Discussion, pp. 210–214, Feb. 28, 1907. Mech. Eng. 19. pp. 487–489, April 6, 1907. Abstract. Locomotion Automobile, 14. pp. 229–230, April 18, 1907.)—The author has investigated experimentally the question as to whether there is any real foundation for the view commonly held that a "fat" spark is better than a weak spark from an ignition point of view. A 2-cylinder engine was employed, all the experiments being made on one cylinder only, the other cylinder working with the usual trembler coil and 4 volts. The speed varied between 950 and 1,000 r.p.m. The results are shown in a series of indicator diagrams for which the original should be referred to. The chief conclusions arrived at are as follows: (1) The character of the ignition spark has no appreciable influence on the power developed (in the type of engine tested). (2) With a trembler coil the time at which the spark occurs is liable to vary; the power developed may thus be much reduced. (3) The variation in the time of firing is different for different coils, and hence where each cylinder has a separate coil the maximum power is probably not obtained, especially at high speeds. (4) With a single coil and high-tension distributor the current should be kept well above a certain critical value; if near the critical value, a slight decrease in current will cause the timing to be defective. (5) Regularity of working in the trembler is of more importance than length or "fatness" of spark. (6) A plain coil with rapid break on the two-to-one shaft is preferable to a trembler coil, except that the engine cannot be started in this way. A combination of the two methods, with the trembler acting for starting, is suggested. L. H. W.

AUTOMOBILISM.[1]

497. *Sturtevant Petrol Car with Automatic Change-speed Gear.* (Automotor Journ. 12. pp. 141–142, Feb. 2, 1907.)—A 45-h.p. six-cylinder horizontal engine is fitted. Normally the engine runs at minimum speed, the governor balls remaining in a neutral position. On depressing the control pedal the engine is accelerated and the governor balls rise to a position where the low-speed gear clutch is engaged, and the car thus starts slowly. Further depression of the pedal accelerates the engine still more and inserts successively the higher gears. On the engine slowing down, as when the car comes to a hill, the gears succeed one another in the reverse order. Illustrations are given. L. H. W.

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

498. *Tractive Resistance on Roads.* **C. H. Hudson.** (West. Soc. Engin., Journ. 11. pp. 660–681; Discussion, pp. 681–685, Dec., 1906.)—The author describes a series of experiments made to determine the resistance to motion of pneumatic-tyred vehicles on roads of various qualities of surface. A retardation method is employed: the car is run up to the desired speed and a Morse tape recorder started, to record half-seconds and revolutions of the road wheels; the engine is next disconnected and the car allowed to run until it comes to rest, the exact instant of stopping being recorded on the tape. A similar run is then made over the same road but in the opposite direction, for the purpose of eliminating irregularities due to grade or wind. The results are set out in curves, plotted between (1) distance and time, (2) speed and time, (3) resistance and speed; others give the resistance at various speeds, distance curves on grades, and a comparison with Morin's resistance formula. The author's terminology makes it more difficult to follow the results [he speaks of a loss of velocity in feet per sec. in place of a retardation, and of the attraction of gravity as being "said to be 32·16 ft. per sec." (*sic*)]. The retardation R, due to road-resistance, air-resistance, and the axle and internal friction is, after simplification and introduction of the numerical coefficients, found to be as follows: $R = W\sqrt{\frac{V + 18\cdot4}{251}}$ for good hard roads, where W is weight in lbs., R is in lbs., and V in ft. per sec. This can be extended to include other road surfaces by addition of a constant increment m whose value varies from 0 for good smooth hard roads to 0·02 for rough macadam roads in bad repair. The wheels employed were 30 in., 30 in., and 36 in. in diam., with 3-in., 3½-in., and 4½-in. tyres respectively. The experiments did not go far enough to show the effects of variations in size of wheels and tyres. L. H. W.

499. *Coefficient of Air-resistance to adopt for Aeroplane Calculations.* **F. Ferber.** (Comptes Rendus, 144. pp. 680–682, March 25, 1907.)—The author points out that aviators have always refused to accept either the values for the air-resistance coefficient experimentally determined by Renard (0·085) and by Canovetti (0·07) or the law of Newton, that when a plane is moving and makes an angle γ with its trajectory the resistance it experiences is proportional to $\sin^2\gamma$, the employment of $\sin^2\gamma$ leading to enormous sizes of the sustaining surface as being necessary. Duchemin's law is, however, recognised which gives, for small inclinations, $kSV^2 \sin\gamma$. The value generally employed for the coefficient k is 0·13, 0·16, or 0·20, and from Maxim's and Langley's experiments may be 0·3. The author shows that even this last figure is too small, and arrives at the following formulæ based upon the fact that an aeroplane may have a perfectly flat trajectory (from photographic measurements), which proves that equilibrium of the forces exists:—

$$F = P(\alpha + \gamma + \gamma_1^2/\gamma), \quad k = P/SV^2\gamma, \quad \gamma_1^2 = s/S,$$

where F is the tractive force in kg. required to keep the aeroplane on a trajectory of inclination α with velocity V in m./sec., P the weight in kg., S the carrying surface in m.², s the apparent surface which resists the motion, γ the inclination of the plane, and γ_1 the most favourable inclination. Here (when equilibrium exists) $F = 0$ and $\alpha = -2\gamma_1$, the angle of inclination is observed, V is ascertained, and P/S is known. Hence k can be determined, and then s. The values of s can be used to classify aeroplanes according to their power of cleaving the air. Thus for Lilienthal's experiments $k = 0\cdot4$;

for Chanute's $k = 0\cdot68$ ($\gamma = 9\frac{1}{2}^\circ$); for the author's $k = 0\cdot7$ ($\gamma = 6\frac{1}{2}^\circ$). But since exactly the same result is obtained when this value of k (0·7) is used and $\sin\gamma = 0\cdot1$, or when the formula $0\cdot07SV^2$ is used for the case of motion of the plane in a direction normal to its surface, the author is driven to the conclusion that "*When a surface is moving either orthogonally or nearly tangentially to its trajectory the air-resistance it experiences is the same.*" This, however, only applies to certain very thin aeroplanes. L. H. W.

REFERENCES.

500. *Coal Consumption of Boilers.* **N. A. Carle.** (Power, 27. pp. 232–233 April, 1907.)—The author gives a chart combining grate areas in sq. ft., boiler efficiencies from 55 to 75 per cent., heat values of coal from 10,000 to 15,000 B.Th.U. per lb., and boiler h.p. without and with superheat, and a scale of coal consumption in lbs. per hour per sq. ft. of grate area, and describes its use in two examples in which the rate of coal consumption under given conditions is ascertained. F. J. R.

501. *Brittleness in Steel and Fractures in Boiler-plates.* **C. E. Stromeyer.** (Mech. Eng. 18. pp. 522–526, Oct. 13, 1906. Abstract of Memorandum to Manchester Steam Users' Assoc. Page's Weekly, 9. pp. 1040–1043, Nov. 9, 1906.)

502. *Heat Non-conducting Coverings for Steam Pipes.* **D. R. MacLachlan.** (Mech. Eng. 19. pp. 197–200, Feb. 9, and pp. 231–234, Feb. 16, 1907. Paper read before the Leeds Univ. Engin. Soc.)

503. *Types of Enclosed Steam Water Heaters.* **C. R. Allensby.** (Mech. Eng. 19. pp. 412–415, March 23, and pp. 475–478, April 6, 1907. Paper read before the Civil and Mech. Engin. Soc., March 7, 1907.)—Reviews various forms of feed-heaters and calorifiers for use with live steam and exhaust steam. Illustrations are given of good and bad types to emphasise the important features of design. [See also Abstracts Nos. 1551, 2084 (1900), 1176, 1178 (1902), 1191, 1351 (1905). F. J. R.

504. *Graphical Methods of ascertaining the Radiation Losses during Calorimetric Work.* **A. Gramberg.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 262–264, Feb. 16, 1907.)—The author discusses in this paper the temperature losses due to radiation when using the bomb calorimeter for fuel testing, and gives three graphical methods for determining these losses in a quick and simple manner. The methods cannot be adequately described without the accompanying diagrams. J. B. C. K.

505. *Gas-engine Improvement.* **F. Sellge.** (Stahl u. Eisen, 27. pp. 222–228, Feb. 13, 1907. Paper read before the Hauptversamml. der Südwestdeutsch-Luxemburgischen Eisenhütte, Metz, Jan. 13, 1907.)—A general discussion of the difficulties of efficient working of the gas engine and the means adopted for the removal of such difficulties. A. W.

506. *Trials of Suction Gas Plants at Derby.* (Engineer, 102. pp. 608–611, Dec. 14, and pp. 639–640, Dec. 21, 1906. Report. Engineering, 82. pp. 843–844, Dec. 21, 1906.)—The official report of the R.A.S. trials, supplementary to the description of the engines and plants dealt with in Abstract No. 903 (1906). The tables should be referred to in the original as they are too bulky for reproduction. L. H. W.

507. *Thermal Properties of Water and Steam at High Temperatures.* (Engineering, 83. pp. 334–335, March 15, and pp. 472–473, April 12, 1907.)—Reviews the recent work of Dieterici and of Knoblauch and Jakob. [Abstracts Nos. 1238A and 1484A (1905)], 358 and 667A (1907).]

INDUSTRIAL ELECTRO-CHEMISTRY, GENERAL ELECTRICAL ENGINEERING, AND PROPERTIES AND TREATMENT OF MATERIALS.

508. *Rosset's "Allotropic" Lead Accumulator.* (Centralblatt Accumulatoren, 8. pp. 61–62, April 20, 1907.)—In this article it is shown that the method briefly indicated by Jeantaud [Abstract No. 21 (1907)] for the preparation of his so-called "allotropic" lead is a somewhat difficult and certainly uncommercial process. Tests with the lead so obtained show that neither has it a smaller electrochemical equivalent nor does it contain a larger amount of energy than ordinary lead; and since these were the chief distinctive properties of the "allotrope," it is concluded that Jeantaud did not obtain anything but ordinary lead. The probable explanation of the good test results quoted by Rosset was given in Abstract No. 146 (1907). L. H. W.

509. *Alternate-current Electrolysis.* **J. L. R. Hayden.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 103–131, Feb., 1907. Electrician, 58. pp. 969–972, April 5, 1907. Abstract.)—The author has carried out laboratory experiments on alternate-current electrolysis in solutions of various salts, and also in soils taken from different spots. Quantitative results are given. He concludes that alternate current produces an electrolytic effect which is not reversible, but rarely exceeds 0·5 per cent. of that of an equal direct current. Nitrates tend to increase corrosion; carbonates or an alkaline reaction produce an opposite effect, but without neutralising the presence of nitrates. Lead is more easily attacked than iron. The effects produced do not necessarily depend on current density, unless this is great enough to cause a rise of temperature. A low frequency generally produces more corrosion than a higher one, but no general law is deduced from the experiments, and something depends on the chemical character of the electrolyte. Ammonium salts and nitrates cause great increase of corrosion with decreasing frequency, while carbonates or an alkaline reaction may give little or no increase under similar conditions. Using lead plates as electrodes, the author found that the superposition of a direct current, equal to about 1·5 per cent. of the alternate current, produced almost complete protection against electrolysis. With a direct current equal to 3·8 per cent. of the alternate current, he found the protection to be complete, and the lead was less attacked by the salts contained in the soil than it would have been if no current had been passing.

W. H. S.

510. *Factory Scale Experiments with Fused Electrolysis.* **E. A. Ashcroft.** (Electrochem. Ind., N.Y. 4. pp. 143–146, April; 178–180, May, and pp. 357–358, Sept., 1906.)—The author deals with the subject in three articles. I. After explaining that the inherent difficulties of dealing with fused electrolytes have been greatly exaggerated, a description is given of his design for a vat for electrolysis of fused zinc or lead chloride. It consists of a brick-lined steel casing, with pockets connected to the fused metal for introducing the current and tapping, and with feed-hole and gas exit in the cover. The anode is introduced through the cover. Details are given of construction

and working conditions. The cost for electric energy for producing zinc and lead from their chlorides with current costing $10 per h.p.-year is calculated at $9·65 and $8 per metric ton, for zinc and lead respectively. A description is then given of the author's process for causing agitation in the electrolyte by magnetic means [see Abstract No. 1408 (1906)], and of the application of this principle to the electrolytic production of zinc and sulphur from zinc sulphide suspended in zinc chloride, based upon Swinburne's original method. II. The application of the rotary magnetic action for different reactions is considered in detail, chemical equations being employed to show the resulting reactions, although the author points out that numerous intermediate reactions may be taking place in the cell. A magnetic rotary cell specially adapted for removing impurities which may accumulate in the electrolyte is described. III. The application of the previously described methods of electrolysis and of an apparatus employing a rotating solid disc magnetically driven for untried metallurgical processes is discussed, the treatment of mixed ores being particularly dealt with. Finally the author deals with the question of the capital involved in large-scale experiments and the national characteristics of English, American, and German workers and capitalists in attacking problems involving considerable speculative outlay. J. L. F. V.

511. *Electrolytic Precipitation of Gold from Cyanide Solutions.* C. B. Richmond. (Electrochem. Ind., N.Y. 5. pp. 144–145, April, 1907. From Engin. and Mining Journ., March 16, 1907.)—Description of the modified Butters' process, as used in the San Sebastian Mines, San Salvador. The very complex sulphides and tellurides contain very little silver. They are roasted, and gold and copper were hitherto precipitated simultaneously on lead kathodes, which had to be sent to smelters, who paid only for the 8·87 per cent. of gold, and not for the 65 per cent. of copper. The author precipitates as before the gold and copper together on lead kathodes, $\frac{1}{16}$ in. thick, against anodes of $\frac{1}{8}$ in. of lead peroxide; up to 90 per cent. of the gold is deposited, the rest being subsequently precipitated in zinc boxes. The lead kathodes are then provided with frames and sacks of cotton, and made anodes in sulphuric acid; the copper is dissolved and loosely deposited on the lead kathodes (of these tanks), which afterwards serve for the first process, while the gold collects in the anode slime. H. B.

512. *Insulating Diaphragm for Molten Electrolytes.* (U.S. Pat. 842,256. Electrochem. Ind., N.Y. 5. pp. 142–143, April, 1907. Abstract.)—G. O. Seward and F. v. Kuegelgen propose to use two water-cooled curtain diaphragms instead of the usually applied single diaphragm, on which the fused electrolyte solidifies, but which may play the part of an intermediate electrode. The diaphragm consists of two concentric annular troughs of cast iron, which are insulated from one another and constructed for separate circulation of cold water. H. B.

513. *Electrolytic Production of White Lead.* (U.S. Pats. 846,526 and 847,082. Electrochem. Ind., N.Y. 5. p. 142, April, 1907. Abstracts.)—In order to render the white lead more homogeneous, C. P. Townsend improves the circulation in his electrolytic cells, whose electrolyte consists of 10 parts of sodium nitrate or acetate with 1 part of carbonate. The electrodes are vertically arranged; the anode is a lead sheet in the middle of the cell; the kathodes are perforated sheets or a cylinder of metal or of wire gauze near the sides.

The electrolyte enters below and passes along both sides of the anode through the perforations of the kathode, down into the filter press, and returns after regeneration to the electrolytic cell. The surface of the kathode is much smaller than that of the anode. The CO_2 introduced into the cell further improves the circulation. The cell can be rotated. H. B.

514. *Production of Silicides and of Silicon Alloys.* (U.S. Pat. 842,278. Electrochem. Ind., N.Y. 5. p. 141, April, 1907. Abstract.)—As both Si and Mn are lost by evaporation when silica and manganese dioxide are heated in arc furnaces, F. J. Tone [see Abstract No. 27 (1907)] recommends a resistance crucible whose two vertical electrodes dip into the flux of lime or fluorspar. The charge consists of 88 parts of silica, 24 of manganese dioxide, 21 of carbon, 17 of lime, or of a siliceous ore and some reducing agent. A silicide of Fe and Mn is prepared from ferro-manganese, silica, carbon, and flux. H. B.

515. *Nickel Silicide and Ferro-nickel Silicide from Sulphide and Silicates.* (U.S. Pats. 847,267 and 847,800. Electrochem. Ind., N.Y. 5. pp. 140-141, April, 1907. Abstracts.)—T. L. Willson smelts in his carbide arc furnaces mixtures of nickel sulphides or silicates, lime, silica, carbide, to obtain silicides of nickel and of ferro-nickel, utilising the waste products of sulphidic nickel ores. The point is to bind the S by Ca. For this purpose enough lime should be allowed to bind all the sulphur to CaS; further, enough silica to bind all the Ca to $CaO(SiO_2)_2$; and further, enough carbon to reduce both the Ca and Si. In practice, however, half these theoretical amounts will suffice, as some of the sulphur is "dissociated and volatilised." It is also pointed out that the silicides can be tapped off from under the calcium sulphide, so that comparatively less lime and more silica will be required after the first few hours. New-Caledonian ores, silicates of Fe, Ni, Mg, can be treated in this way. H. B.

516. *Reduction of Metallic Sulphides.* (U.S. Pat. 846,642. Electrochem. Ind., N.Y. 5. p. 142, April, 1907. Abstract.)—E. L. Anderson proposes to reduce sulphides somewhat on the lines of Salom and of Betts under generation of H_2S. The electrodes are vertically fixed, long slabs of carbon, the two anodes near the sides of the tank, the kathode in the middle. The kathode is surrounded by a wire-gauze basket, which is packed with the ore, *e.g.*, blende ground to 15- or 20-mesh. The electrolyte is hydrofluosilicic acid. Over the kathode is suspended a bell in which the H_2S collects; this gas is burned in gas engines which drive dynamos. The zinc from the $ZnSiF_6$ is at once deposited on the kathode. H. B.

517. *The Electro-thermic Combustion of Atmospheric Nitrogen.* F. Howles. (Soc. Chem. Ind., Journ. 26. pp. 290-297; Discussion, pp. 297-298, April 15, 1907. Paper read before the Manchester Section.)—Referring to the researches of McDougall and himself, of Nernst, Muthmann and Hofer, and of Brode [see Abstract No. 624A (1906)], the author points out that nitric oxide is formed in zone 1 of Brode's arc flame, and that both ozone and NO are dissociated in zones 2 and 3; the temperature of zone 3 is higher than Muthmann's estimate (900° or 1,000° C.). To secure a high yield of NO the temperature of the flame should be high—it is 4,200° C. in zone 1—and (secondly) the NO should be removed as quickly as possible out of the flame, as rapid cooling is technically impossible, or (thirdly)

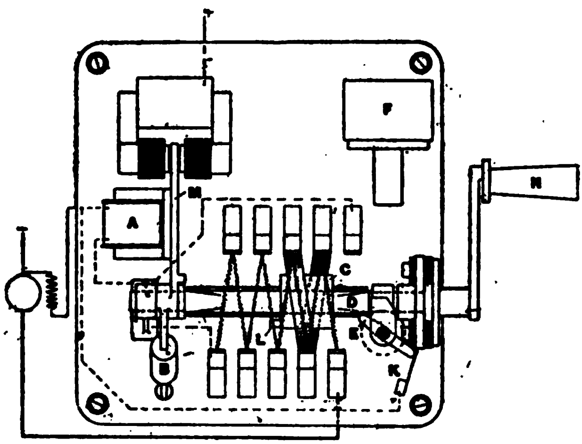
zones 2 and 8 should be relatively small. Fourthly, the arc currents should be small, yet the flame energy large. The author proceeds to a critical review of the processes of Kowalski and Moscicki, Birkeland and Eyde, and others. The Badische Anilin- und Sodafabrik have constructed transformers to avoid the necessity of producing the arc disc with the aid of special coils. But they seem to apply different apparatus, long iron tubes 1 m. in length, with one insulated electrode at the lower end and the upper end earthed; air is sent up the tube in whirls, and the arc strikes from the electrode to the tube wall and travels along the wall; several such tubes are used on the several phases of polyphase circuits. Naville and Guye turn a disc electrode about its vertical axis, above the tube through which the air passes. Pauling inclines the electrodes as in lightning-arresters of the horn type so that the arcs travel up the electrodes; Pauling and also Häusser further send the air through incandescent fine tubes of porcelain, without the intervention of electrical energy. The author further considers the absorption of the NO, the preparation of nitric acid and the costs of the electric processes with regard to different power sources, water, steam, Mond gas, and blast-furnace gas. In the *discussion*, **H. Porter** remarked that some nitric oxide was formed during the catalytic sulphuric acid process, and **R. S. Hutton** criticised the author's cost estimates for the power. [See also Abstract No. 876 (1907).] H. B.

518. *Electrical Smelting Furnace.* (Brit. Pat. 28,959 of 1906. Engineering, 88. p. 585, April 19, 1907. Abstract.)—A. Hiorth places two induction furnaces of the annular groove type side by side. The magnet core is common to the two, the vertical branches passing through the centres of the rings. The charge may be fed in intermittently, and a detachable partition can be fixed in the groove. Electrodes are provided on both sides of this partition; these electrodes dip into the slag and are joined above to a secondary coil on the core. The current will pass chiefly through the slags and produce "energetic" slags. H. B.

519. *Electrolytic Alternate-current Meter.* (Brit. Pat. 1968 of 1906. Engineering, 88. p. 508, April 12, 1907. Abstract.)—W. M. Mordey and G. C. Fricker have modified their prepayment meter in such a manner as to render it suitable for use on alternate-current circuits. In this meter a copper voltameter is used; by dropping a coin through a slot and turning a handle, a definite length of thin copper-foil anode may be immersed in the electrolyte, and the supply will be maintained until the anode is dissolved, when the current is automatically cut off. In order to adapt the meter to alternating currents, the inventors adopt the simple expedient of connecting a small secondary cell in series with the meter; the continuous component of the current alone produces an electrolytic effect, but since this component is directly proportional to the alternating-current component, the meter so modified is suitable for use on alternate-current circuits. A. H.

520. *New Motor Starter.* (Elect. Rev. 60. pp. 258–354, Feb. 15, 1907.)—A new pattern motor starter, made to the designs of H. W. W. Dix by the Phœnix Dynamo Manufacturing Co., Ltd., employing a screw-driven helical drum for cutting in and out the armature resistance. The Fig. shows the arrangement of the starter and safety devices. M is a switch-arm held in by a no-volt coil A against the tension of a spring B; C is the helical drum having a lug L by which the switch M is closed; H is the starter handle turning the square

shaft D; K is a spring-operated switch normally short-circuiting the no-volt coil, but capable of being opened by the lever E. To start the motor the handle H is turned clockwise, the switch K being held open with the other hand. The drum C then moves to the left until the switch M is closed by the lug L. Coil A is then excited, and also the motor field, all the armature resistance being in circuit. The motor is then speeded up slowly by rotating H counter-clockwise, the resistance being gradually cut out. The circuit



is broken by giving a quarter turn clockwise to the handle, this movement releasing the switch K and bringing out the main switch M. F is an overload coil which when energised closes a switch short-circuiting the coil A. Full field excitation is obtained during starting as the exciting current never passes through the starting resistance. The device can be adapted for the starting of induction motors. [See also Abstract No. 2284 (1904).]

W. E. W.

521. *Resistivity Temperature-coefficient of Metals.* **H. Pender.** (Electrical World, 49. p. 756, April 13, 1907.)—The author advocates the adoption, for simplicity's sake, of the formula $R_1/T_1 = R/T$, where R = resistance at t^0, R_1 its resistance at any other temperature t_1, T and T_1 signifying respectively the temperatures $t^0 + 238$ and $t_1 + 238$. This figure $-238°$ for the (absolute zero) zero resistance of copper is, however, based upon the acceptance of the value for the coefficient (0·0042) adopted by the Amer. Inst. Elect. Engin. The formula lends itself to use with the slide rule in a very simple manner. [See also Abstracts Nos. 1045 (1906) and 882 (1907).] L. H. W.

522. *New Type of High-voltage Insulator.* (Elektrotechn. Zeitschr. 28. pp. 439–440, April 25, 1907.)—A new type of insulator, constructed of ambroin, is being placed on the market by the Vereinigte Isolatorenwerke A.-G., of Berlin-Pankow. It is made of several parts screwed together; the screw thread is formed by moulding the material. In order to protect the top of the insulator from spark discharges, it is fitted with a grooved porcelain cap which forms the support for the wire; this cap is screwed over the top section of the ambroin insulator. In the case of very high voltages, the lowermost section is fitted with a screwed brass lining which takes the in-

sulator pin. Insulators of this type are cheaper and lighter than those of porcelain, and tests—of which an account is given—carried out by the Reichsanstalt have shown that they are superior to porcelain in their insulating qualities. In one test, an ambroin and a porcelain insulator having the same diameter were connected in parallel. The height of the first was 85 mm., that of the second 195 mm.; and the weights were 375 and 2,850 gm. respectively. When subjected to 60,000 volts and a heavy artificial rain, the porcelain insulator was completely enveloped in flames, while the ambroin one only showed slight discharges. A. H.

523. *Analytical Representation of Hysteresis Loop.* **E. Müllendorff.** (Elektrotechn. Zeitschr. 28. pp. 361–362, April 18, 1907.)—The author finds that the hysteresis loop may be represented with a fair degree of accuracy by the empirical formula—

$$B = B_0 \frac{\sin(\phi - a_1 \cos\phi)}{\cos(a_2 \cos\phi)},$$

wherein a_1 and a_2 are constants, B_0 is the maximum induction, and ϕ the phase angle of the alternating magnetic force. If the maximum value H_0 of the magnetic force varies, then for a given frequency n the instantaneous induction may be represented by—

$$B = B_0 \frac{\sin\left(\phi - b_1 e^{-\frac{c_1 n}{H_0}} \cos\phi\right)}{\cos\left(b_2 e^{-\frac{c_2 n}{H_0}} \cos\phi\right)},$$

in which b_1, b_2, c_1, and c_2 denote constants whose values are easily determined. A. H.

REFERENCES.

524. *Conventional Symbols for representing Electrical Apparatus and Plant.* **Brunswick.** (Soc. Int. Élect., Bull. 7. pp. 103–114, Feb., 1907.)—The symbols recommended by the Sub-committee appointed to deal with this matter are given.

525. *Mechanism of Power Transmission from Electric Motors.* **W. L. Spence.** (Inst. Engin. and Shipbuilders, Trans. 50. 5. (pp. 8–58); Discussion and Correspondence, 50. 6. (pp. 16–32), 1906–1907. Elect. Engineering, 1. pp. 682–685, April 18; 713–715, April 25, Discussion and Communication pp. 768–769, May 2, 1907. Abstract.)—The different mechanical devices employed in the driving of machinery by means of electric motors are illustrated, the subject being dealt with under the following headings: Motor location, Belt drives, Direct-coupled drives, Flexible shaft drives, Direct-coupled vertical shaft drives, Spur-wheel drives, Idler-wheel drives, Self-contained reducing gears, Planetary gears, Chain drives, Worm-gear drives, Variable-speed drives. The ratios within which each form of gear is applicable are stated, and considerations of cost dealt with in some cases. L. H. W.

GENERATORS, MOTORS, AND TRANSFORMERS.

526. *Design of Commutating Poles.* **F. Pelikan.** (Elektrotechnik u. Maschinenbau, 25. pp. 253–255, March 31, 1907.)—By considering diagrams giving the approximate flux distribution in the teeth and core in the immediate neighbourhood of a reversing pole, the author is led to establish the following relation connecting the angular reversing pole width b_r with the angular width of brush b, the angular widths of tooth t and slot s, the number of commutator segments K, the number of slots Z, and the angular width w of a commutator segment :—

$$b_r = b - 2t(1 - a) - s + \left(\frac{K}{Z} - 1\right) w.$$

In the above, a is a coefficient such that the higher its value the better the commutation. In general, a would be made equal to unity, but if a compounding effect is desired a may be made > 1. A. H.

527. *Internal Currents in Three-phase Generators.* **A. G. Grier.** (Elect. Journ. 4. pp. 189–199, April, 1907.)—If the e.m.f. wave of a three-phase generator contains a third harmonic, and if the windings be Δ-connected, internal currents will circulate in the windings, which have the effect of increasing the copper and iron losses, and hence causing an increased temperature-rise. For this reason, the star connection is the safer from the designer's point of view. If a delta connection be adopted, due consideration should be given to the shape of the pole-face and other factors affecting the shape of the e.m.f.-wave. Oscillograms are given by the author showing the effect of such internal currents on the flux distribution over a pole, the wave-shape being determined with the delta first open and then closed. In one machine experimented on by the author, the internal current in the unloaded armature amounted to the full-load current of the machine.

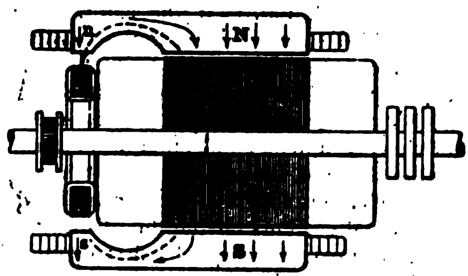
A. H.

528. *Efficiency of Direct-current Machines.* **F. Loppé.** (Ind. Élect. 16. pp. 153–154, April 10, 1907.)—To measure the efficiency of direct-current machines, one or other of two methods is usually employed. In the first method the individual losses in the machine are calculated as accurately as possible. In the second method two identical machines are required. If the machines are directly coupled mechanically, one acting as a motor driving the other as a generator (H. Fontaine), then, if the electric power generated in the latter be W′, and W be the power supplied to the generator, it is assumed that $\eta = \sqrt{W'/W}$. It is more customary to apply Hopkinson's test, and even if the machines are not identical good results can be obtained. Official rules for testing machines usually specify this test. A combination of the Hopkinson method with the method of calculating losses leads to excellent results. The methods of Rayleigh and Kapp, Potier, Hutchinson, and Blondel are briefly described. A. R.

529. *Centrifugal Stress Factor.* **E. Siedek.** (Elektrotechn. Zeitschr. 28. p. 425, April 25, 1907.)—The author draws attention to the fact that in con-

nection with high-speed machines it is customary to state the peripheral speed only, which, however, by itself gives no information regarding the centrifugal stress, this latter depending also on the angular velocity. He suggests the introduction of a centrifugal stress factor, defined as the radial force per unit mass due to centrifugal effect. If m stand for the revs. per min., and v for the peripheral velocity in m./sec., the centrifugal stress factor, expressed in kg. per kg. mass, is given by $(uv/100) \times 1{\cdot}07$, or, approximately, by $uv/100$. It is desirable to state the value of the centrifugal stress factor as well as the peripheral speed in dealing with high-speed machines. A. H.

530. *Self-regulating Two-pole Turbo-alternator.* **A. Heyland.** (Elektrotechn. Zeitschr. 28. pp. 829–834, April 11, 1907. Electrician, 58. pp. 998–1001, April 12, 1907.)—The machine described by the author presents a further development of the principle recently applied by him to the design of large slow-speed alternators [Abstracts Nos. 1806 (1906) and 298 (1907)]. The design of turbo-alternators, in which the number of poles is necessarily very small, presents considerable difficulties from the point of view of regulation, and a satisfactory result can only be obtained at the expense of an excessive amount of material. By the application of the principle of the magnetic shunt to a two-pole turbo-alternator, the author claims to have designed a machine which combines good regulation with small amount of active



material. The general arrangement of the machine is shown in the Fig., in which N, S stand for the poles of the alternator, and n, s for those of the exciter. The poles are surrounded by common exciting coils. The alternator armature rotates, and carries on its shaft the exciter armature. With increasing demagnetising effect of the armature current, the flux through the exciter increases, thereby automatically increasing the exciting current; the machine will regulate for power-factor as well as for current, since the increase in the exciter flux is simply proportional to the demagnetising ampere-turns on the armature. The regulating action is instantaneous. In order to bring out the advantages of the new design, the author compares the weights of steel, iron, and copper in a 500-kw. machine of the new type with those in a machine of ordinary construction; this shows a saving of some 25 per cent. in iron and steel, and a saving of over 50 per cent. in copper, accompanied by a considerable reduction in the iron and copper losses.

A. H.

531. *Methods of Determining Retardation.* **A. P. Young.** (Electrical World, 49. p. 551, March 16, 1907.)—Measurements of retardation are of importance in connection with the well-known tests for determining efficiency and separating losses. The usual method of finding the retardation at any

speed is by making use of the time-speed curve. The author suggests two *direct* methods. In each of these a small continuous-current generator whose field is maintained constant is belted to the machine under test. In the first method, the armature of the small dynamo is connected, through a suitable resistance, to the primary of a transformer having a ring-shaped core provided with an air-gap (in order to secure proportionality between flux and current), a suitable secondary winding being in connection with an electrostatic voltmeter. The reading of this latter instrument at any instant will evidently be proportional to the retardation at that instant. In the second method, the armature of the small dynamo is connected in series with a galvanometer and condenser; the galvanometer reading is then proportional to the retardation. A. H.

532. *Construction of Rotors of Turbo-alternators.* (Brit. Pat. 2,151 of 1906. Engineering, 83. p. 508, April 12, 1907. Abstract.)—The invention described, which is due to C. A. Parsons, G. G. Stoney, and A. H. Law, relates to a method of supporting the flanks of the field-coils against that component of centrifugal stress which is parallel to the pole-shoes. The coils are subdivided into two or more sections, and are secured by means of bolts passing through the spaces between the coil sections into the poles, the bolt-heads resting against plates applied to the flanks of the coils. A. H.

533. *Heating of Field Coils.* **G. A. Lister.** (Inst. Elect. Engin., Journ. 38. pp. 399–414; Discussion, pp. 414–427, April, 1907. Paper read before the Birmingham Section. Abstracts in Electrician, 58. pp. 410–411, Dec. 28, 1906; p. 448; Discussion, pp. 448–450, Jan. 4, 1907. Elect. Rev., N.Y. 50. pp. 101–105, Jan. 19, 1907. Écl. Électr. 50. pp. 242–243, Feb. 16, 1907. Elektrotechnik u. Maschinenbau, 25. p. 86, Jan. 13, 1907.)—After drawing attention to the discrepancies among the various coefficients used in determining the probable temperature-rise, and the different ways of estimating the cooling surface, the author gives the results of a series of tests carried out by him, and compares them with those obtained by previous experimenters. He suggests the following values for the sq. cm. of *total* surface (including surface in contact with core) per watt corresponding to a temperature-rise of 50° C.:—

	Sq. cm. per watt.
A. Machine on open circuit—	
Medium-size plain coil	35
Medium-size coil wound on metal former which slips loosely over core	31
B. Machine fully loaded—	
Small two-pole machines, armature above magnets	20
Moderate size protected motors	40
„ „ semi-enclosed motors	50
„ „ „ „ with commutating poles	60
Open type machines, 50 kw.	25
„ „ 500 kw.	30

In the *discussion*, **L. Murphy** confirmed the author's result that the surface in contact with the core was about as effective as the external surface; he found, however, that if the temperature-rise be considered with respect to time, a coil in position on its core will heat more slowly than when freely suspended. **R. T. Glazebrook** maintained that two coefficients, one relating

to the external surface and the other to that in contact with the core, should be employed. **H. M. Hobart** expressed himself strongly in favour of the determination of temperature-rise by resistance measurements. **C. C. Hawkins** drew attention to the advantages resulting (in the case of large machines) from dividing each coil into, say, three sections, separated from each other by intervening air-gaps of ¼ in., and having distance-pieces between the coils and their core, so as to allow air to pass freely between the core and coils and radially outwards between the coil sections. A. H.

534. *Calculation of Eddy-current Losses in Armature Teeth.* **F. E. Meurer.** (Electrical World, 49. pp. 792–795, April 20, 1907).—After pointing out the discrepancy which is known to exist between the calculated and the actual values of the eddy-current losses in the armature teeth, the author shows how results more nearly corresponding to those obtained in practice may be arrived at by taking into account the law according to which the flux is distributed in the gap, and making an allowance for the additional loss in the surface layers of the tops of the teeth, which practically form a thin continuous conducting layer. The author's method involves the analysis of the flux curve into its fundamental and third harmonics (higher harmonics being neglected), and the calculation of appropriate coefficients to be applied as correction factors to the orthodox formula. A. H.

535. *Improvement in Compound-wound Three-wire Generators.* (Electrical World, 49. p. 785, April 20, 1907.)—An objection which has been urged against compound-wound three-wire generators is the necessity of duplicating the equaliser conductors when several machines are to be connected in parallel, since the series winding is arranged in two sections connected in series with the two outer mains. In a recent patent, E. Rosenberg gets over this difficulty by including the main part of the series winding in one of the outer conductors only, and connecting a supplementary winding, having half the number of turns of the main winding in series with the neutral conductor. This winding is traversed by a current equal to the algebraic sum of the currents in the outer mains (U.S. Pat. 849,085). A. H.

536. *Commutating Poles for Three-wire Generators.* (Brit. Pat. 2,705 of 1906. Engineering, 83. p. 567, April 26, 1907. Abstract.)—When the commutating pole windings are all arranged on either the positive or the negative side of a three-wire generator, it is obvious that the conditions required for sparkless running cannot be secured if the load is unbalanced. This defect Siemens Bros. & Co., Ltd., J. C. Wilson, and W. G. Griffith propose to remove by providing the reversing poles with a double set of coils, one set being connected in series with the positive outer main, and the other in series with the negative one. A. H.

537. *Constant-Power Dynamo.* (Elektrotechnik u. Maschinenbau, 25. p. 332, April 28, 1907.)—The following method of regulating the power of a dynamo driven at a constant speed has been patented by Balachowsky and Caire (D.R.-P. 176,429). Coupled to the dynamo is an exciter which supplies its field winding. One end of the field winding is also in connection with one set of the main armature brushes, and an intermediate point of the winding is connected to one of the mains. The remaining main is in connection with the other set of brushes. Thus a section of the field coil is traversed by the

main as well as by the exciter current, the connections being so arranged as to produce opposition of the two currents, the field being thereby weakened and the e.m.f. reduced, with increase of load—resulting in approximate constancy of power. A. H.

538. *Improvements in Machines for Intermittent Loads.* (Elektrotechnik u. Maschinenbau, 25. p. 338, April 28, 1907.)—The Siemens-Schuckertwerke propose to replace the mechanical coupling of a flywheel to a shaft driving an intermittent load by an electrical one (D.R.-P. 175,407). The flywheel is mounted on a special shaft which carries the armature of a buffer dynamo electrically coupled to a dynamo mounted on the main shaft. By means of a centrifugal governor, which is arranged to insert or withdraw résistances in the field circuits of the machines, the e.m.f.'s are so governed that an increase of load and consequent decrease of speed causes the buffer dynamo to act as a generator, and to supply power to the dynamo on the main shaft, the opposite effect taking place when the load decreases and the speed rises. The same firm proposes (D.R.-P. 168,211) to supply with currents of variable frequency the rotor of the three-phase motor driving the generator which supplies current to a motor intended to deal with a variable load (such as a winding engine). This current of variable frequency is obtained from an auxiliary machine driven by a continuous-current motor provided with a supplementary field winding which is traversed by the main current of the generator or a convenient fraction of it. As the load on the main generator increases the field of the small motor is weakened, causing it to run faster, and thereby increasing the frequency of the currents supplied to the rotor of the three-phase motor. This has the effect of reducing the rotor speed and that of the generator driven by it. R. Braun has devised (D.R.-P. 167,247) a method of driving winding engines by single-phase commutator motors supplied from a polyphase generator. In this way the advantages of such motors are combined with those of polyphase transmission, and a uniform torque is maintained even with very low frequencies. A. H.

539. *Design of Small Motors.* **H. M. Hobart.** (Elect. Engineering, 1. pp. 52–57, Jan. 10, 1907.)—The author discusses the general procedure to be adopted in the manufacture of motors in large quantities with a view to cheapening the cost of production and obtaining a maximum number of ratings from a minimum number of component parts. The commutating pole type is suitable for small motors only in the case of abnormally high speeds and where a wide range of speed variation by shunt control is desired. The author expresses the opinion that there is a good deal of room for improvement in the way of reduction in weight in most motors of British manufacture, but that the possible limit of weight is rapidly being approached by Continental and American firms. A. H.

540. *Hunting of Motors with Reversing Poles.* **K. W. Wagner.** (Elektrotechn. Zeitschr. 28. pp. 286–289, March 28, 1907. Écl. Électr. 51. pp. 181–184, April 27, and pp. 167–171, May 4, 1907.)—After referring to the hunting observed in the case of motors fitted with commutating poles, and the explanations of this effect advanced by Breslauer [Abstract No. 1118 (1905)] and Siebert [Abstract No. 829 (1906)], the author attacks the problem mathematically, establishing and integrating the equations of motion (1) on the supposition that the armature current does not affect the total field flux,

and (2) on the assumption that the main flux is altered by an amount proportional to the armature current. It is shown that in case (1) the motor is absolutely stable, while in case (2) instability may result if the main field is weakened by the armature current. Interpreted from a purely physical point of view, hunting involves the supply of a variable amount of power from the network to the motor, and the development of a variable amount of mechanical power by the motor; but the instant of maximum supply of electrical power does not coincide with the maximum of mechanical power—hence the energy transformations which result in hunting. A. H.

541. *Zigzag Leakage of Induction Motors.* R. E. **Hellmund.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 827–846, March, 1907.)—The author points out the loose way in which many writers define the leakage coefficients of an induction motor, and discusses four of the ordinary definitions. The first definition is that the primary leakage coefficient τ_1 is given by $\tau_1 = R_s/R_p$, where R_s = the reluctance of the path of the flux interlinked with the secondary windings, and R_p = the reluctance of the path of the total flux interlinked with the primary winding. The second definition is $\tau_2 = F_p/F_s$, where F_p = the total flux interlinked with the primary winding, and F_s = the flux interlinked with the secondary winding. A third definition is $\tau_3 = R_p/R_e$, where R_e = the reluctance of that part of the flux which is interlinked with the primary but not with the secondary winding; and the fourth definition is $\tau_4 = F_e/F_p$, where F_e = the flux interlinked with the primary but not with the secondary winding. Since $F_p = F_s + F_e$, we easily find that $\tau_2 = 1/(1-\tau_4)$, and a similar relation between τ_1 and τ_3 can be found. The author examines the last two definitions. A diagram illustrating the magnetic fluxes in a three-phase induction motor, when the rotor and stator teeth are not exactly opposite to one another, is drawn. By the method of duality the problem is then transformed into one in current electricity. The currents in the reciprocal network are found by Kirchhoff's and Ohm's laws, and reciprocating the solution the required magnetic fluxes are obtained. Expressions are found in this manner for the instantaneous values of the primary and secondary fluxes, assuming the curves of current to be sine-shaped and the secondary circuits open. The values of τ_4 are then plotted for various relative positions of the teeth of the stator and rotor. When the rotor slots are shifted a distance of one-quarter of a tooth against the stator slots, τ_4 varies from 0 to 0·177 and its average value is 0·097. When the rotor slots are shifted a distance of half a tooth, τ_4 varies from 0 to 0·25 and the average value is 0·184. The value of τ_3 in this case is 0·388. τ_3 and τ_4, therefore, are two entirely different quantities in practice. The following explanation is given of the difference in the values of τ_3 and τ_4. The magnetomotive forces and the magnetic flux densities near the boundaries of a pole are considerably smaller than near its centre. Hence the flux near the boundaries, which is practically all leakage flux, is much smaller than it would be in the case of a uniformly distributed field. The value of τ_4 is what is wanted in practice. To define τ_3 as the leakage coefficient, as done by Heyland, Behn-Eschenburg, and others, is not correct unless the clumsy expedient of introducing another coefficient to give the ratio of the m.m.f. of the main field to that of the leakage field is also adopted. The author shows that when the motor is working on a load, not only does the speed as a whole vary, but the various parts of the magnetic field move with different speeds. The problem is thus much more complex than the simple one usually discussed. The author's practical experience in design has proved to

him that it repays the designer well to use accurate formulæ, even if these are lengthy and complicated. For routine work formulæ are hardly necessary, as most of the factors are known by previous tests, but when designing a new line of machines, even although the improvement obtained by taking the lengthy formula into account is a small one, the money saved may be considerable. This paper is merely preliminary. No definite formula is arrived at, but the author has succeeded in getting several steps nearer to the solution.

A. R.

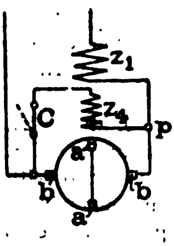
542. *Short-circuiting Device for Rotors of Induction Motors.* (Brit. Pat. 1,691 of 1906. Engineering, 83. p. 508, April 12, 1907. Abstract.)—S. v. Ammon proposes the following method of gradually reducing the resistance of the rotor winding of an induction motor. The winding being of the squirrel-cage type, the conductors are at one end connected to a ring in the usual way. At the other end they are made flexible, are of considerable length, and are curved towards the shaft, their ends being connected to fingers projecting downwards from a ring carried by a spider which may be slid along the shaft. The uppermost portion of the ring supporting the fingers consists of copper. The fingers and conductors are curved in such a manner that in one extreme position—the starting position—of the spider they are clear of each other except at the joints which connect their lower extremities. As the spider is slid outwards along the shaft, more and more of each flexible conductor is brought against the surface of its corresponding finger, until finally the outer copper ring is pressed against the conductors, thereby short-circuiting them entirely. A. H.

543. *Variable-speed Induction Motor.* (West. Electn. 40. p. 255, March 23, 1907.)—The motor described has been patented by C. P. Steinmetz (U.S. Pat. 848,774). The rotor is made the primary member, and is fitted with slip-rings through which it receives current from the mains, and also with a commutator. By means of the commutator brushes, low-frequency currents are obtained which are fed into the stator windings. By varying the voltage impressed on the stator, the speed may be varied; auto-transformers, choking coils, or resistances may be used for this purpose between the commutator brushes and the points of connection to the stator winding. A. H.

544. *Methods of Starting Single-phase Induction Motors.* (Electrical World, 49. pp. 584–585, March 23, 1907.)—A brief account of three recently patented methods of starting single-phase motors. The first is the invention of A. R. Everest (U.S. Pat. 847,172), and involves the use of a switch which is maintained in the starting position by an electromagnet so connected between the auxiliary winding and a resistance and inductance arranged in parallel with it that at starting the magnet is traversed by a strong current, which steadily decreases with increase of speed, finally becoming so small that the switch is released and thrown into the running position by the action of a spring, the auxiliary winding being thereby cut out. The second method is due to E. J. Berg (U.S. Pat. 847,158), and involves the use of a condenser both for starting purposes and for improving the running conditions. The third method, devised by C. R. Meston and H. I. Finch, is one in which the rotor is at starting disconnected from its shaft, and, when a certain speed has been reached, is automatically coupled to the shaft, the starting winding being at the same time disconnected by the aid of a centrifugal device (U.S. Pats. 844,883 and 4). A. H.

545. *Controlling Speed of Compensated Single-phase Commutator Motors.* (Elect. Engin. 39. p. 469, April 5, 1907.)—E. Arnold and J. L. La Cour have recently patented a method of controlling the speed of compensated single-phase commutator motors. The armature is provided with two sets of brushes, one set being short-circuited and the other connected in series with the stator winding having the same magnetic axis. Arrangements are provided for varying the number of turns in this stator winding, or for varying the turns in both stator windings (the second winding being directly across the mains). Diagrams are given showing various modifications of this method. A. H.

546. *New Single-phase Commutator Motor.* M. Osnos. (Elektrotechn. Zeitschr. 28. pp. 836–840, April 11; and pp. 858–861, April 18, 1907.)—The motor described by the author has been developed by the Felten and Guilleaume-Lahmeyerwerke, and is so designed that it may be made to possess either a series or a shunt characteristic, the transition from the one condition to the other being effected by a simple switch. The general arrangement of connections is shown in the Fig., in which z_1 denotes the main stator winding, while z_4 represents an auxiliary stator winding, termed the transformer winding. At starting z_4 is entirely disconnected, and the motor starts as an ordinary compensated series motor. When it has run up to nearly synchronous speed the switch C may be closed, and the motor then becomes practically a constant-speed motor. The author considers this type of motor with special reference to its suitability for lift work. The conditions which a good lift motor should fulfil are enumerated, and from these it appears that none of the commutator motors at present in use is entirely suitable. The new motor, however, possesses the necessary characteristics. It starts as a series motor, and is so proportioned that it may be connected directly across the mains, without the use of any starting resistances; the starting torque is at least 2·5 times the normal full-load torque, and the starting current twice the full-load current. When the motor has attained a certain speed, a centrifugal device mounted on its shaft closes the switch C, thereby converting the motor into a constant-speed one: all risk of racing is thus avoided. If the motor be driven mechanically above its normal speed, it will act as a generator and exert a powerful braking effect, returning energy to the mains. Its power-factor is nearly unity at all loads. Various methods of supplying the motor through series transformers are described. The motor is stated to have come into extensive use in practice. A. H.



547. *Improved Single-phase Series Motor.* (Mech. Eng. 19. pp. 600–601, April 27, 1907.)—A new method of compensating a single-phase series motor has been patented by M. Latour. This consists in connecting the compensating winding in parallel with the armature, so that the current on traversing the field winding splits up, part flowing through the armature and the remainder through the compensating winding. The connections are so arranged that the magnetic effects of the two currents oppose each other, and the currents will be such as to reduce the resultant flux to a minimum value, the division of the main current so as to produce this effect being entirely automatic. Thus armature reactance will be neutralised more or less perfectly. There is another extremely important advantage which

results from the new arrangement. The armature rotation e.m.f. produces a local current in the circuit formed by the armature and the compensating winding, and with respect to this internal current the local circuit is a highly inductive one, and the flux produced by the local current in the compensating winding is in quadrature with the main current, and is thus available for neutralising the transformer e.m.f. in the short-circuited coil, and securing sparkless commutation at all loads. With the above simple arrangement, perfect compensation could not be obtained owing to magnetic leakage. The inventor therefore proposes to correct the effect of leakage by one or other of two alternative arrangements. In the first, the compensating winding is connected in series with the secondary of a series transformer before being connected in parallel with the armature, the primary of the transformer conveying the main current. In the second, the compensating winding is on one side connected to one of the brushes, and on the other to a suitable point in the field winding, so that a certain number of field turns are included in the local circuit. A. H.

548. *Variable-speed Shunt-wound Motor.* (Electrical World, 49. p. 782, April 20, 1907.)—An invention recently patented by J. C. Lincoln has for its object the prevention of sparking at the higher speeds of the variable-speed motor devised by him [Abstract No. 1192 (1906)]. The speed is increased by a screw mechanism which withdraws the conical armature from the field in an axial direction, thereby decreasing the flux. As the armature is withdrawn, it comes under the influence of a specially constructed electromagnet arranged just outside the main field, which provides a commutating field and also further weakens the flux passing into the armature, thereby preventing a drop of speed with increase of load. The auxiliary magnet is provided with series coils (U.S. Pat. 847,088). A. H.

549. *Regulation of Series-connected Series-wound Motors.* (Elektrotechnik u. Maschinenbau, 25. p. 384, April 28, 1907.)—In order to maintain equality of p.d. across two series-connected series-wound motors, Thury makes use of two small auxiliary motors which are connected across the armatures of the main motors, and which are mounted on the shaft of a regulator, the connections being so arranged that the torques oppose each other. If the p.d. across one motor armature rises above that across the other, the torque of the corresponding auxiliary motor overcomes that of the other, and a rotation of the regulator takes place, which weakens the field of the motor having the higher brush p.d. by altering a shunting resistance across its field (D.R.-P. 168,288). A. H.

550. *Rotary Converters v. Motor Converters.* **M. Walker.** (Inst. Elect. Engin., Journ. 38. pp. 428–486; Discussion, pp. 486–451, April, 1907. Paper read before the Manchester Section. Abstracts in Electrician, 58. pp. 828–829; Discussion, pp. 829–831, Dec. 14, 1906. Elect. Rev., N.Y. 49. pp. 1006–1009, Dec. 22, 1906.)—The author briefly compares the various types of apparatus at present available for transforming alternating into continuous current, considering them with reference to starting, parallel running, variation of voltage, hand regulation of voltage, compounding, commutation, risk of breakdown, power-factor, efficiency, attention, and floor space. Although the 50-∿ rotary converter is still regarded by many as a delicate and unstable piece of apparatus, the author maintains that the behaviour of such

converters of recent design has shown them to be thoroughly reliable and satisfactory in operation. As compared with the motor converter [Abstract No. 1188 (1905)], the rotary converter has an efficiency which is at least 1½ per cent. higher. In the *discussion*, conflicting opinions are expressed with regard to the relative merits of rotary as against motor converters. [See also Abstracts Nos. 887 (1906) and 408 (1907).] A. H.

551. *Frequency Changers.* **J. P. Jollyman.** (Electrical World, 49. p. 698, April 6, 1907.)—The frequency changers considered by the author are synchronous machines intended to effect the change from 60 to 25 cycles, or *vice versâ*, and the author's remarks are based on experience gained with two 4,000-kw. sets at San Francisco. The highest possible speed for a 60–25 cycle set is 300 r.p.m., and this was the speed adopted in the sets mentioned. Corresponding to this speed, the 60-cycle machine has 24 poles, and the 25-cycle one 10 poles. The sets are started by applying half voltage from suitable transformer taps to the armature of either machine, the field circuit being open. The current drawn from the mains amounts to about half the full-load current of the machine, the power-factor being low. In a little over a minute, the set runs up to synchronous speed, and the current drops to about ¼ of its full-load value. While the machine is still being supplied at half voltage the field circuit should be closed, a sufficient amount of resistance being included to produce only about half the normal field flux. But since the polarity due to the three-phase current may be opposed to that produced by the exciting current, the latter by wiping out the existing field and establishing one in the opposite direction would cause a large rush of current into the armature, until the rotor had dropped back a pole. In order to prevent this, the field is connected to a reversing switch, and a mere touch of the switch-blade against its jaws is, by its effect on the armature current, sufficient to indicate to the operator whether the polarity is right or wrong. The field circuit having been closed, the exciting current is raised so as to correspond to an armature e.m.f. about half-way between half and full voltage, and the armature is then transferred to the full voltage taps. A set of the speed considered can be paralleled with a like set on both sides only once during one revolution of one set with respect to the other. Certain precautions must be observed in order to secure proper division of the load between the machines when paralleling. Assuming one set to be running loaded, and the other to have been started from the 60-cycle side, a maximum phase displacement (due to field distortion) of about 25 electrical degrees between the e.m.f.'s of the loaded and the incoming machine will exist when the load is a non-inductive one, and hence it is necessary to make an allowance proportional to the load, and to parallel on the 25-cycle side when the synchronism indicator shows the incoming machine to be from 0 to 25° fast. Once the machines have been paralleled the division of the load cannot be appreciably altered by adjustment of the fields, even if one field be made nearly twice as strong as the other. A. H.

552. *Transformer Diagrams.* **T. R. Lyle.** (Phil. Mag. 13. pp. 468–480, April, 1907. Paper read before the Physical Soc., Feb. 22, 1907.)—The author has applied the wave-tracer devised by himself [Abstract No. 75 (1904)] to the direct determination of the wave of resultant or magnetising ampere turns and the wave of magnetic flux of a transformer. The first wave is obtained by connecting to the commutator a secondary coil which is placed between two primaries, one of which carries the primary and the

other the secondary current; the ratio of the mutual inductances of the secondary relatively to the two primaries being equal to the ratio of the turns in the transformer coils. The paper is accompanied by curves obtained with a ½-kw. transformer at no load, non-inductive load, and inductive load of power-factor 0·78. Incidentally, methods are developed for comparing mutual inductances, and for measuring both mutual and self-inductances in terms of a resistance and a time. A. H.

REFERENCES.

553. *Use of Commutating Poles in Railway Motors.* **W. H. Warren.** (Electrical World, 49. pp. 308–309, Feb. 9, 1907.)—Owing to the much greater armature reaction which may be permitted in a motor with commutating poles, such a motor will require a smaller field flux for a given torque. The author shows that as a result a commutating-pole motor may be designed to give a very much (95 per cent.) larger starting torque with a given current than a motor of ordinary design of the same weight and output and running at the same speed. A. H.

554. *Differential Compound Winding for Generators and Motors.* (Engineer, 103. pp. 201–202, Feb. 22, 1907.)—In Brit. Pat. 2364 of 1906, M. W. W. Mackie proposes, in connection with a wave-wound armature, the use of a demagnetising series winding arranged on a few of the field poles only. A generator provided with such a winding may be made to give an approximately constant brush p.d. with varying speed. A. H.

555. *Rotary Converters* v. *Motor Generators.* **Weiss.** (Elektrotechn. Zeitschr. 28. pp. 183–185; Discussion, p. 185, Feb. 21, 1907. Paper read before the Elektrotechn. Gesell., Köln, Jan. 17, 1906.)—A general discussion of the relative advantages and disadvantages of rotary converters, synchronous and asynchronous motor-generators. A. H.

556. *Commercial Unipolar (Homopolar) Machines for Higher Voltages.* **W. Wolf.** (Verein zur Beförd. des Gewerbefleisses, Verh. No. 8. pp. 400–416, Oct., 1906.)—Deals very fully with the type of machine described by Noeggerath [Abstract No. 218 (1906)], which is now also manufactured by the A.E.G.

557. *Reciprocating Electric Motor or Dynamo.* (West. Electn. 39. p. 375, Nov. 10, 1906.)—A description of a machine patented by P. Boucherot in which direct attraction and repulsion are made use of, the movement being converted into a rotary motion by means of devices of the nature of free-wheel clutches. Illustrations are given. L. H. W.

558. *Armature Reaction in Synchronous Motors and Rotary Converters.* **B. T. McCormick.** (Canad. Elect. News, 17. pp. 104–106, April, 1907. Elect. Rev., N.Y. 50. pp. 684–685, April 27, 1907. Elect. Engin. 39. pp. 547–548, April 19, 1907. Paper read before the Canadian Soc. of Civil Engineers.)—The author discusses armature reaction in synchronous machines by the aid of vector diagrams, and as examples of the application of the method determines the reactance which must be connected in series with a compound-wound converter in order to obtain a given compounding effect at a given power-factor, and traces the V-curve of a synchronous motor. A. H.

559. *Transformer Testing.* **E. A. Reid.** (Elect. Engin. 39. pp. 159–161, Feb. 1, 1907. Paper read before the Dick-Kerr Engin. Soc., Jan. 25, 1907.)—Practical notes on the subject.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

560. *Pressure-rises in High-voltage Circuits.* **C. P. Steinmetz.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 803–825, March, 1907. Elect. Rev., N. Y. 50. pp. 679–681, April 27, 1907.)—The author classifies and briefly studies the theory of the various disturbances which are capable of bringing about an abnormal rise of voltage in a transmission circuit. Such disturbances are considered under three heads: (1) Those in which there is a gradual rise in an insulated transmission system of its mean potential relatively to earth; (2) those in which a violent local disturbance sends a wave of potential along the line; (3) those represented by a stationary wave. The mean potential of an insulated transmission line may be gradually raised by an accumulation of electric charge due to rain, snowdrift, or fog carried across the line, or to electrostatic induction from a passing cloud, or to differences of atmospheric potential in different regions traversed by the line, especially if this latter passes over mountain ranges. Similar effects arise from a want of symmetry in the generator (such as that caused by one of the lines of a three-phase system becoming earthed), and from the existence of higher harmonics in the e.m.f.-wave. As regards (2), such disturbances may be caused by a direct lightning stroke, by the inductive effect of neighbouring lightning discharges, by a spark discharge from one line to another or to earth, or by sudden changes of load. Disturbances of class (3) may be caused by connecting or disconnecting a transmission line, by suddenly opening a short-circuit, &c. Their frequency varies from a low value approaching the commercial frequencies, up to very high values (several hundred million cycles per sec.), and the physical effect produced by them depends largely on their frequency; as a general rule, the lower frequencies are the more dangerous. The disturbances discussed may occur either singly, or simultaneously, and one kind of disturbance may cause another. A. H.

561. *System of Underground Mains.* (Brit. Pat. 1,944 of 1906. Engineering, 83. p. 469, April 5, 1907. Abstract.)—The system described forms the subject of a patent by J. S. Highfield, and is specially intended for use with high-voltage, continuous-current systems. The conductors consist of bare copper cables, threaded at intervals through porcelain insulators supported inside a system of iron pipes connected by air-tight joints. The insulators have the form of a double truncated cone with a strongly corrugated surface to reduce leakage, the conductor passing through a perforation along the axis of the double cone, and being thereby supported so as to occupy the axis of the pipe. Rings of some soft material are interposed between the porcelain insulators and the walls of the pipe. The insulators are spaced sufficiently close together to prevent undue sagging of the conductor, and the conductor is anchored at intervals in suitably constructed boxes. The interior of the piping is coated with some insulating material, such as asphalt or pitch. By means of an air-pump, a current of dry air is maintained through the system of pipes, the air being allowed to escape slowly by a number of valves. Pressure gauges are provided at various points, and so long as their readings remain constant, it may be inferred that everything is in order. A. H.

582. *Westinghouse System of Electric Winding in Collieries.* (Elect. Engineering, 1. pp. 125–127, Jan. 17, 1907.)—The power drawn from the supply mains is in this system maintained approximately constant by means of a flywheel set consisting of a flywheel coupled to a continuous-current machine, which acts as a motor while the flywheel is being accelerated, and as a generator while it is being retarded. Assuming the power supply to be a three-phase one, connection would be established between the supply mains and the flywheel machine by means of step-down transformers and a rotary converter. The field of the flywheel machine is controlled automatically by a quick-acting regulating apparatus, which is actuated by series transformers whose primaries are in the supply mains. The main motor driving the winding engine is a three-phase one, and is connected directly across the supply mains. The rotary converter is specially compounded so as to supply the necessary wattless current to the main motor. The advantages claimed for this "converter-equaliser" system are: (1) The size and cost of the machines required, and the energy loss involved, are small, owing to the fact that only the fluctuations in the total demand have to be dealt with, the normal power being supplied directly to the main motor without any transformation; (2) one converter-equaliser can be used to equalise the variable load of an entire system; (3) the converter-equaliser may be connected to the high-voltage mains at the most convenient point, without regard to the position of the winding motor. If desired, the system can also be used in connection with a continuous-current winding motor. In this case, the entire power must be transformed by the rotary converter, which on its continuous-current side is connected to a dynamo mounted on the same shaft with the flywheel machine. Regulation is then effected as described in Abstract No. 461 (1905). A. H.

583. *Economy of Entz Reversible Booster.* (Electrician, 58. p. 940, March 29, 1907.)—Results are given showing the saving effected by a reversible booster and buffer battery in the Greenock generating station. By installing the booster-battery plant on the traction system, a saving of 20 per cent. on the total coal consumption has been brought about, and it has been possible to run with 30 per cent. less generating plant, although the maximum traction load has increased. In order to secure such satisfactory results, the action of the booster must be instantaneous. A. H.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

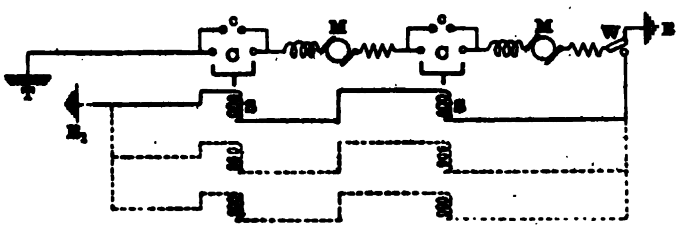
584. *Development of Electric Traction.* (Soc. Int. Élect., Bull. 7. pp. 81–102, Feb., and pp. 227–262, April, 1907. Discussion.)—[For R. de Valbreuze's paper see Abstract No. 204 (1907).] In the *discussion*, M. Latour explained the chief characteristics of the series, repulsion, and compensated repulsion motors, with some of the improvements which had been made in their design, and pointed out that the commutation difficulties at starting constituted their principal defect. Guéry dealt with the use of buffer batteries, both for regulating the load on the generators and as a reserve of energy. In the absence of such a battery the generators ought to have a large overload capacity, even double the normal output, instead of increasing the number or

[1] Non-electrical automobiles are described in the Section dealing with Steam and Gas Engines.

size of machines, and the copper in the mains need not be materially increased. Provided that the generators have sufficient overload capacity, batteries can be dispensed with in traction power stations without inconvenience. **Gratzmuller** described a system of single-phase traction devised by himself and Bunet. In order to obtain high initial torque with economy, frequency changers are employed, consisting of autotransformers with rotating brushes working on commutators of comparatively small dimensions. This device also makes possible the recuperation of energy whilst slowing down. A. H. A.

565. *Accident on the New York Central Railroad.* (Street Rly. Journ. 29. pp. 461–468, March 16, 1907. Engineering, 83. pp. 478 and 479–481, April 12, 1907.)—The strain imposed upon the track by steam and electric locomotives in rounding curves at high speeds is discussed in the light of investigations carried out in consequence of the recent accident, and tables and diagrams are given. For a speed of 60 m.p.h. on a 8° curve, with a super-elevation of 4½ in., it is found that the maximum shear on the spikes of the outer rail is for the electric locomotive 5,820 lbs., and for the steam locomotive 4,890 lbs., while the ultimate shearing resistance of the spikes ranges from 14,440 to 17,060 lbs. each. With two spikes effective to resist the pressure, the factor of safety is about 6. A. H. A.

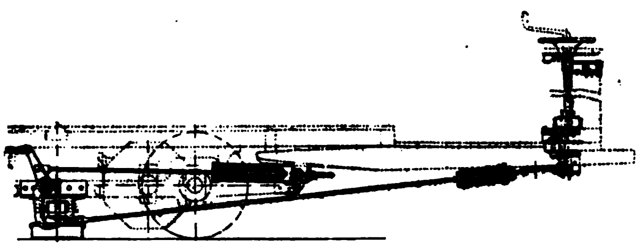
566. *New Multiple-unit System of Train Control.* (Electrician, 59. pp. 9–11, April 19; and pp. 48–51, April 26, 1907.)—A new multiple-unit system of train control—the invention of T. v. Zweigbergk, of Dick, Kerr and Co., Ltd. —has been in use during the last few months on the Liverpool-Southport section of the Lancashire and Yorkshire Railway. The following are the main features of the system: (1) The use of contactors operated by series



magnets having no appreciable inductance, and hence responding promptly to the operation of the master controller; (2) the fact that no current is ever interrupted in the master controller, and hence the possibility of entirely dispensing with blow-out arrangements in the controller, which take up a good deal of space, it being only necessary to provide blow-out coils in the contactors; (3) the maintenance of the control wires at practically zero potential, with consequent safety from the insulation point of view. The principle underlying the system will be readily understood by reference to the Fig., in which T denotes the contact shoe, MM the two motors of a motor coach, *cc* contacts in the master controller, CC contactor contacts, operated by the series solenoids SS. The dotted lines indicate other contactor solenoids arranged in parallel with the contactors S. W is a two-way switch, by means of which the current on leaving the motors may either be allowed to go directly to the earth E in the front part of the train, or be diverted

through the solenoids to the earth E_1 at the rear end of the train. To allow of control from either end of the train a master controller is provided in each of the end coaches, the control wires being run throughout the train, and corresponding solenoids in neighbouring coaches connected in series with each other. There are two reverser contactors, a resistance contactor, and a series-parallel contactor, and each contactor contains four series solenoids. When starting the switch W is on the lower contact, so that when the contacts *cc* are closed the solenoids required are energised, different solenoids being brought into circuit or cut out according to the position of the master controller. The controller handle is fitted with a mechanical regulator which only allows of notching up one step at a time. In order to switch off the motors the controller handle is brought back to its zero position by a single sweep, establishing contact at E, and causing all the contactors to drop off. The contactors are fitted with the metallic shield blow-out. A. H.

567. *The Freund Tramway Brake.* (Engineering, 83. pp. 210 and 212, Feb. 15, 1907. Tram. Rly. World, 21. pp. 204–206, March 7, 1907.)—This article deals with a new type of brake, patented by E. Freund, which in some recent tests succeeded in stopping a tramcar in a shorter distance than any of its competitors. The brake acts on the track, as will be seen in the Fig., the brake blocks being guided by horn plates fixed to the framing of the truck [only one wheel of truck shown]. Each shoe is



attached by means of a connecting rod to the end of a short horizontal lever keyed to a cross-shaft, the bearings of which are bolted to the inside of the side frames. Vertical levers keyed to the same shaft are connected to strong compression springs, attached to the end crossbar of the truck. Each spring exerts a mean pull of about 18 or 19 tons, which tends to turn the rocking-shaft and force the brake shoes down on to the track. The brake is normally held off by one or other of the winding spindles on the driver's platforms. The chain from the lower end of each spindle is connected by means of a pull rod to a lever keyed to the rocking-shaft. Into these pull rods are inserted compression springs, by means of which the brake pressure can be varied from nothing up to its maximum value. By means of the regulating spring a counter pull is effected which balances a smaller or larger part of the pull exerted by the power springs, and the difference of these pulls gives the brake pressure. The winding gear consists of the usual spindle, on the top of which a hand wheel is fixed, while a pinion, which engages with a gear wheel, is mounted on the lower end. The ratio of these wheels is about 1 to 5. The larger gear wheel is keyed to a chain barrel, upon which the winding chain can be taken up by turning the hand wheel clockwise. Instead of the usual ratchet wheel and pawl for arresting the winding spindle, a ratchet pawl is mounted on the tubular shaft, and engages with teeth on the top of the brake pulley, which is free to turn

round the tubular shaft. A leather-lined brake band, kept tight by a spring attached to the brake lever, normally makes this pulley a fixture. The pivot of the strap brake is extended upwards, and is provided with a lever, against which the driver presses with his body when he wants the brakes to go on. It depends on the length of time during which he keeps this strap brake open how far the winding spindle will spin back. The farther it spins back the more will the regulating spring get released and the higher will the brake pressure become. If the brake pressure is not high enough at any time the driver presses against the controlling lever. If the brake pressure is too high, he turns the hand wheel clockwise and reduces it to any extent desired. In case of emergency he only presses more rapidly against the controlling lever and keeps the strap brake open till the regulating springs are entirely released. This does not take longer than it requires to turn the handle of the electric controller into the "off" position, which means that the brake is full on at the same moment as the current is cut off. The article closes with a list of points in which this brake is superior to either the magnetic or pneumatic brakes. In addition to these it also fulfils a request which the Board of Trade often makes, viz., that the track brake be put on before a car enters a down gradient. C. E. A.

568. *Breaking of Trolley Wires.* **P. S. Sheardown.** (Inst. Elect. Engin. Journ. 38. pp. 603–606, June, 1907. Abstract of paper read before the Dublin Section. Tram. Rly. World, 21. pp. 118–119, Feb. 7, 1907. Elect. Rev. 60. p. 121; Discussion, pp. 121–122, Jan. 18, 1907.)—Analyses the usual causes of such breakages. The main cause is considered to be the change in molecular condition of the trolley wire, due to repetitions of stress not purely tensile. As remedies the author suggests that a wire capable of withstanding the bending and vibration stress it will have to endure be specified, that the trolley should be erected for smooth under-running, and that the upward pressure of the trolley should be as small as possible. L. H. W.

569. *Electric Signals of the Metropolitan Railway of Paris.* (Ind. Élect. 16. pp. 154–158, April 10, 1907.)—The Hall system is in use [see Abstract No. 572 (1903)]. All signals are normally at danger and have the same signification. They are placed generally on the one side 50 m. on the advance direction of the station, and on the other side at the point of departure from the station. When the distance between two stations is large, or the curvature of the track requires a slower speed, a supplementary signal is installed between the two stations. The security of the system is well established. It has been worked since the middle of the year 1900 on the line Vincennes-Maillot, Dauphine-Trocadéro. During a day of 20 hours 104 signals have been constantly in use. Those of the line Vincennes-Maillot are brought into play every 8 min. Since the opening of the system more than 50 million operations of the signals have been effected. On this line the pedal is used as well as the track relay. By the action of the pedal, which has a slow movement of release as it works in a dash-pot, a controller is actuated, and notifies the stationmaster of a station towards which the train is directed if a danger signal is run past. The Hall system of signalling by track relays is also in use on the P.L.M. Railway between Laroche and Cravant, 45 km. of double line, and at the junctions of the Ceinture line with the stations of Ivry and Bercy. E. O. W.

ELECTRIC LAMPS AND LIGHTING.

570. *Three-phase Arc Lamp.* **C. Bentivoglio.** (Atti dell' Assoc. Elettr. Ital. 11. pp. 58–62, Jan.-Feb., 1907.)—The author has designed three forms of arc lamp for three-phase current: one for 10 to 20 amps., a small lamp for 2¼ to 8 amps., and an inverted lamp for about 10 amps. There are three carbons set at an angle of about 30°, so that their tips are at the angles of an equilateral triangle. The carbons being connected to the three poles of the three-phase circuit, arcs are started in delta-connection between their tips, never less than two being alight at once. It is stated that the arc can be easily maintained at distances up to 18 mm., and that it will work satisfactorily at as low a frequency as 17 cycles per sec. Cored carbons are used, and the lamp will work with the impregnated carbons used for flame lamps. The regulation is effected by a rotating-field motor, in which two fields rotating in opposite directions are connected in shunt and in series respectively. It is found that the three carbons burn quite uniformly, the explanation suggested being that if one carbon tend to become shorter than the others, the two arcs formed at its tip will be weakened in comparison with the third arc, and the difference will thus be compensated. The efficiencies attained are given as follows: Flame carbons, 37·5 volts, 20 amps. per phase, frequency 38·5; 6,920 Hefner candles vertically, 7,810 at 22·5°, and 5,670 horizontally. With ordinary cored carbons, 51 volts, 15 to 17 amps. per phase, frequency 51; 7,880 Hefner candles vertically, 5,210 at 45°, and 2,817 horizontally.

A. E. L.

571. *The Davy enclosed Arc Lamp.* (Elect. Engineering, 1. p. 514, March 21, 1907.)—This lamp, which is adapted for series burning, has only a series electromagnet with a horseshoe core suspended from one end of a balance beam and pulling directly against a spiral spring. This arrangement has the advantage that the increasing pull of the solenoids on the horseshoe core as it enters the solenoids is balanced by the increasing pull of the stretched spring, so that the working stroke of the core can be much increased. The other end of the balance beam is connected by pivoted links to the piston of an inverted air dash-pot, and to a clutch of the usual rocking washer type.

C. K. F.

572. *Experiments with Magnetite Electrodes.* **W. Eminger.** (Dingler's Polytechn. Journ. 322. pp. 11–14, Jan. 5, and pp. 26–29, Jan. 12, 1907. Abstracts in Elektrotechn. Zeitschr. 28. p. 277, March 21, 1907 Electrical World, 49. p. 804, April 20, 1907.)—After referring to Steinmetz's magnetite lamp and to Ladoff's experiments with iron and titanium electrodes, the author describes experiments made with the magnetite electrodes manufactured by the process of the firm of Siemens Bros., of Charlottenburg. Their method consists in fusing oxygen compounds of iron by aid of the arc and running the molten mass into iron tubes. The electrodes tested comprised pure magnetite electrodes, magnetite electrodes with 15, 30, 50, 70 per cent. of rutile (TiO_2), and pure rutile electrodes. The empty iron tube, 200 mm. long, 14 mm. internal diam., and of wall-thickness 0·5 mm., has a resistance of 0·00181 ohm. With 10 amps., the drop is therefore 0·0181 volt. When the tube is filled with pure magnetite or 50 per cent. mixture the voltage drop (lighted lamp) is 0·0188 and 0·02 volt respectively. The increase of rutile increases the content of yellow and green rays in the light while simultaneously the

chemically active rays are diminished. At the same time the volume of the arc gets smaller and the light cone gets sharper. It is very difficult to maintain a pure rutile arc for any length of time. Pure magnetite has a tendency to boil with resulting fluctuations of the arc. This may be avoided if the electrode is artificially cooled, for instance, by using a magnetite electrode with a copper core, the copper conducting the heat away. If this is done magnetite electrodes without addition of titanium give good results. Magnetite (Fe_3O_4) is oxidised in the arc to Fe_2O_3 while rutile is not changed. The final oxidation products are, therefore, not wholly or partially gaseous, but solid. The more rutile contained in the electrodes the less the smoke developed. The author calculates the theoretical quantities of air which are required per hour for a current of 8 amps. for the oxidation process, first for an ordinary arc lamp (58·92 litres), then for an enclosed arc (2·05 litres) and, finally, for a magnetite arc with positive copper electrode (0·028 litre). It would seem that the magnetite arc lamp could, therefore, be used almost under complete absence of air; but the considerable amount of smoke developed makes it necessary to carry it off with air, so that an increased supply of air is necessary. With magnetite containing 50 per cent. or more of rutile it is very difficult to start the arc between the magnetite and the copper if the former electrode is not preheated. With a lamp with an electrode containing 70 per cent. magnetite and 30 per cent. rutile, consuming 7 amps. at 64 volts, the spherical c.p. was 884, hence the specific consumption was 0·587 watts per spherical Hefner candle. For an arc length of 15 mm. the lower hemispherical c.p. and the specific consumption were found to have the following values for magnetite electrodes containing different percentages of rutile :—

	Volts.	Amps.	Watts.	Candles.	Watts per c.p.
15 per cent. TiO_2	60·24	8·75	527	711	0·71
30 " "	61·6	8·4	517	815	0·634
50 " "	63·96	8·54	546	1,000	0·546

For varying arc length, but constant current, the lower hemispherical c.p. and the watts per c.p. have the following values, a magnetite electrode with 30 per cent. TiO_2 being used :—

Arc length in mm.	Volts.	Amps.	Watts.	Candles.	Watts per c.p.
10	52·75	9·58	504	748	0·673
15	63·5	9·75	620	1,062	0·581
20	71·0	9·75	694	1,345	0·515

Finally, the influence of both the arc length and the current on the watts per lower hemispherical c.p, is given in the following table :—

Arc length in mm.	3 Amps.	5 Amps.	6 Amps.	8 Amps.	10 Amps.
			15 per cent. TiO_2.		
5	1·58	0·95	0·65	0·60	0·76
10	1·02	0·6	0·51	0·44	0·41
15	—	—	0·4	0·36	0·34
20	—	—	—	—	0·28
			30 per cent. TiO_2.		
15	0·72	0·41	0·36	0·34	0·32
20	—	—	—	0·3	0·25

For constant current the consumption in watts per lower hemispherical c.p. decreases with increasing arc length. For constant arc length the specific

consumption decreases rapidly with increasing current between 8 and 6 amps., but above 6 amps. the decrease is very slight; the consumption remains then almost constant. On account of the light sent upwards from a magnetite arc lamp, a reflector must be used. All the above figures relate to measurements of the power in the lamp itself, not including any series resistance. The intensity of the light is a maximum in the horizontal plane. Electrodes containing 80 per cent. of rutile are consumed somewhat more quickly than pure magnetite electrodes. The consumption of an electrode containing 80 per cent. rutile was 1·05 mm. at 6 amps., 1·65 mm. at 8 amps. and 2·14 mm. at 9 amps., per hour. It is stated that a 80 per cent. rutile electrode 250 mm. long, 15 mm. diam. costs 56·7 Pf. (7d.) to produce, the selling price being 65 Pf. (8d.). The construction of the lamp used is not referred to. L. H. W.

573. *Three-phase Arc Lamps.* (Elektrotechnik u. Maschinenbau, 25. p. 312, April 14, 1907.)—This lamp, which is the invention of T. L. Carbone (D.R.-P. 180,702 and 181,019), has three convergent downwardly inclined carbons connected respectively to the three phase-wires. The features of the lamp are the use of an arc-deflecting magnet of solid or only slightly subdivided iron, excited by three coils respectively connected to the three phase-wires; and the insertion in the phase-wires of regulable resistances or regulable self-inductions outside or inside the lamp, whereby irregular burning of any of the carbons can be checked. C. K. F.

574. *Experiments on Enclosed Arc Lamps.* **W. Wedding.** (Elektrische Kraftbetr. u. Bahnen, 5. pp. 141–146, March 14, 1907.)—The first set of experiments relates mainly to the efficiency of these lamps and to the rate at which the carbons are consumed. Attention is drawn to the fact that the consumption of carbon is greater when a lamp is turned off and relighted a number of times, this being due to the admission of fresh amounts of air each time. The consumption (with solid carbons) of the negative carbon per hour varied from 0·18 to 0·52 mm., and that of the positive carbon varied from 0·97 to 1·295 mm., the current varying between 5·56 and 6·18 amps. The efficiency, with opal globes 20 cm. long and 7 cm. diam. was from 1·14 to 1·72 watts per mean lower hemispherical c.p. and about 1 watt per l.m.h.c.p. with clear glass globes, the current density varying from 0·0486 to 0·0449 amp. per mm.^{2} and the terminal p.d. at the arc varying from 76·5 to 78·8 volts. Other experiments were made with other current densities and with cored carbons and with alternating currents. It was found that the efficiency is much lower with alternating currents than with direct currents. Polar curves are also given showing the distribution of the light. Experiments were also made as to the effect of shutting off the air. A lamp was burnt with the arc entirely shut off from the air; with the valve open (area 28 mm.^{2}); and also with the valve open and a hole (area 8 mm.^{2}) in the lower part of the clear glass globe. The watts per l.m.h.c.p. were in the ratio of 1 : 1·04 : 0·99. The author regards the difference in the results as within the limit of errors of measurement and of the rapid fluctuations which occur in the efficiency of enclosed arc lamps during burning, so that he does not consider that the more or less complete shutting off of the air has any material influence on the efficiency although it has on the life of the carbons, that is to say, the efficiency is substantially the same as that of lamps with open arcs. Experiments were also made with enclosed arc lamps for use in explosive atmospheres so as to prevent ignition thereof by explosions caused by relighting of the lamp after

extinction, due to admixture of air from the exterior with the CO generated during burning. C. K. F.

575. *Recent Progress in Arc Lamps: Flame Arcs.* **Blondel.** (Soc. Int. Élect., Bull. 7. pp. 137–169, March, and pp. 267–286, April, 1907.)—In the first Part the author reviews recent work on the arc, and gives illustrations of some typical lamps. In the second Part the results of tests are given and numerical data concerning arcs under different conditions. Tables are given showing, for European lamps, the voltage, watts, diam. of carbons, consumption of carbons, luminous flux and c.p., and life of carbons in hours, for lamps grouped two, three, and four in series on 120 volts continuous current, and for alternating current; first of the vertical, and second of the inclined type. Photometric tests carried out at the Paris municipal electricity works of the "Halles" are only briefly referred to, but these have shown that the total luminous flux ϕ can be represented as a function of the current C and voltage V by the following empirical formula :—

$$\phi \text{ (in lumens)} = (34{\cdot}3\,C + 610)\,V + 1550\,C - 25146,$$

for *continuous* currents ranging from 6 to 8 amps. and voltages of 27 to 33. For alternating currents between 12·5 and 16·5 amps. and voltages from 28 to 36, $\phi = (222{\cdot}5\,C + 1878{\cdot}5)V - 4460\,C + 45809$. The following comprehensive table sets forth in comparative form the chief features of the different types of arc. Allowance should be made for possible small differences owing to the different standards employed :—

Lamp Type.	Amps.	Volts.	Watts		Mean Hemi-spherical Intensity.	Watts per Candle.		Carbons used per Hour.
			Useful.	Total.		Ab-solute.	At 110 volts.	
Continuous Current.								mm.
Ordinary carbons	9	40	360	495	700	0·514	0·710	14–16
„ „ (3 in series) ...	9	35	315	330	540	0·583	0·710	14–16
Flame arc, vertical cored carbons	9	40	360	495	910	0·396	0·610	27·5
Intensive flame arc, inclined do.	9	45	405	495	2,000	0·202	0·247	34–42·5
Enclosed arc (American)	6·8	70	476	768	329	1·45	2·334	1·5–2
Magnetite arc	3·5	91	320	385	400(?)	0·800	0·962	1–2
Bremer lamp (9-amp.)...............	9	48	412	495	4,814	0·131	0·143	35–45
Carbo-mineral lamp (9-amp.) ...	9·1	43	391·3	500	4,800	0·081	0·103	16–20
„ „ (5-amp.) ...	5·12	51·6	241·2	282	2,210	0·109	0·128	16–20
„ „ (3-amp.) ...	3·5	80	171·5	165	1,339	0·128	0·124	18–20
Mercury arc	3·5	80	280	385	770	0·362	0·50	—
Ferro-titanium arc	(3)·5	48·3	169	385	700	0·242	0·55	1–2
Luminous arc (Carbone)	10	90	900	1,100	1,070	0·82	0·98	18–20
Alternating Current.								
Ordinary carbons	9	30	270	330	350	0·772	0·945	15–16
„ cored carbons	15	35	480	555	470	1·02	1·18	15–16
Flame arc, vertical carbons	9	30	270	330	700	0·386	0·471	30
„ „ inclined „	9	45	405	495	2,000	0·202	0·247	35–45
Enclosed arc	6·6	70	482	726	814	1·535	2·312	1–2
Bremer lamp	9	48	—	—	—	0·131	0·143	35–45
Carbo-mineral lamp..................	10	35	255	370	1,890	0·135	0·174	15–20
„ (3 in series)........	8	33	225	272	1,000	0·225	0·272	15–20

Finally, taking gas as costing 2d. per m.³ and electricity at 7d. per unit, 400 mean spherical candles are obtainable with incandescent gas lamps for 1·24d. per hour, whilst 1,200 candles are obtainable for 1·4d. with mineralised arcs and continuous current, or for 2·1d. with alternating current. The relative costs per 100 candles are 3·1, 1·17, and 1·75 respectively. L. H. W.

576. *Method of Running Arc Lamps.* (Brit. Pat. 21,094 of 1906. Engineering, 83. p. 469, April 5, 1907. Abstract.)—The object of this invention, patented by Siemens Bros. Dynamo Works, Ltd., is to secure more economical working by doing away with the steadying resistances ordinarily employed with arc lamps. The function of the steadying resistance is performed by a motor-generator of special design. The armatures of the two machines are coupled mechanically, and are connected in series with each other and across the mains. The field of the generator is also directly across the mains, while that of the motor is connected in series with the lamp or lamps and then across the generator terminals. Thus the field of the motor, and hence its own speed and that of the generator are controlled directly by the lamp current, which is thereby maintained automatically constant. The motor-generator may be made relatively small, as only part of the energy undergoes conversion, and in this respect it has an advantage over those motor-generators in which the conversion is complete, and in which a generator having a strongly drooping characteristic is employed. A. H.

577. *Mercury Vapour Lamps operated by Induction.* (West. Electn. 40. pp. 206–207, March 9, 1907. Elect. Mag. 7. pp. 267–269, April, 1907.)—Deals with the subject matter of two patents recently issued to P. Cooper Hewitt, applied for in Sept., 1900. The lamp proposed is made in the form of a sphere, the contents of which act in the well-known way as secondary to a primary winding surrounding the core, as has been so often shown in experimental demonstrations. The novelty consists in the use of mercury vapour in the interior of the spheres, though other conducting vapours are included in the claims. The vapour should be at a low pressure such that the e.m.f. induced in it is from 3 to 50 volts per in., the sphere being 8 in. in diam., when only a few hundred volts will be required. Modifications of the arrangement are described, and include the excitation of the lamp by currents from condenser discharges. With 6,000 volts pressure and a 6-in. bulb a primary coil of 15 turns will suffice. (U.S. Pats. 843,583 and 4.)

L. H. W.

578. *Improving the Colour of the Light from Mercury Vapour Lamps.* (Elektrotechnik u. Maschinenbau, 25. p. 330, April 21, 1907.)—The addition of salts having many red lines in their vapour spectra to the electrodes gives no satisfactory results. G. Peritz (D.R.-P. 174,290) makes use of an addition, in the form of powder, of substances which are not volatilised or vaporised in the mercury arc but only raised to a white heat. Cerium dioxide, thorium dioxide, or zirconia are found to give good results when part of the glass tube is constricted so as to raise the temperature of the arc at this point. In this way the light obtained from the tube may be made to give a continuous, in place of a discontinuous, spectrum. L. H. W.

579. *Light Standards and High-voltage Glow-lamps.* **C. C. Paterson.** (Inst. Elect. Engin., Journ. 38. pp. 271–308; Discussion, pp. 308–349, April, 1907. Abstracts in Electrician, 58. pp. 560–564, Jan. 25; 611–613, Feb. 1; 639–641; Discussion, pp. 641–642, Feb. 8, and pp. 690–691, Feb. 15, 1907. Écl. Électr. 50. pp. 324–326, March 2, and pp. 398–400, March 16, 1907. Elect. Rev., N.Y. 50. pp. 311–312, Feb. 23, 1907.)—The influence of atmospheric conditions on flame standards is first considered. It was found that the variation of the amount of CO_2 in the air had no appreciable effect on the

intensity of the light emitted by a Pentane lamp. The humidity of the air is the most disturbing factor. For the 10-c.p. Pentane lamp it can be taken into account by the formula $10 + 0{\cdot}066(10 - \epsilon)$, where ϵ is the number of litres of water vapour per cub. m. of dry air. Owing to the variation of the proportion of the oxygen and nitrogen in the air a variation of about 10 per cent. might possibly be obtained in a badly ventilated photometer room. The expression giving the variation of the light with the height of the barometer is $10 - 0{\cdot}008(760 - b)$, where b is the height of the barometer in mm. Descriptions and photographs of the Pentane, Hefner and Carcel lamps are given. Expressing the values of all the units in terms of that given by the Pentane lamp the following table is obtained :—

	Pentane.	Hefner.	Carcel.
National Physical Laboratory......	1	0·914	0·982
Reichsanstalt	1	0·917	0·991
Laboratoire Centrale..................	1	0·929	1·000
Laboratoire d'Essais	1	0·928	0·996

The Hefner lamp is the simplest and easiest to set up, but the Pentane lamp has a whiter light. The results obtained by both were more satisfactory than those obtained with the Carcel lamp. This is attributed to a want of constancy in the capillarity of the wicks employed. The results of tests made on Fleming large bulb 200-volt glow-lamp standards are given. They illustrate that high-voltage glow-lamp standards cannot yet be made absolutely trustworthy. Tests made for the Engineering Standards Committee on the ordinary commercial glow-lamps sold in this country prove that they have been rated very badly as compared with American lamps. A comparison is made between a normal life test and an overrunning test on glow-lamps. It was found that the results obtained by running the lamps at an increase of pressure of 40 per cent. over their rated pressure for an hour were of little, if any, help in foretelling how they would maintain their c.p. on a 1,000-hour run at the normal voltage. A discussion is given of the problem of measuring m.s.c.p. with reference to methods of lightening the labour involved. A voltage regulator invented by the author and E. H. Rayner is described. It works satisfactorily, and adjusts automatically alternating voltages to within 0·5 per cent. In conclusion, the author emphasises the importance of accurate photometry in connection with the rating of glow-lamps. The waste of money per annum in this country due to using unsuitable glow-lamps must be very great, and the only way to stop the waste is to encourage those manufacturers who rate their lamps properly and who give an effective guarantee of their quality. In the *discussion*, **J. A. Fleming** states that a large-bulb filament lamp is far better than any flame standard yet made for preserving a standard of light. The filaments should be run for at least 100 hours initially, and then photometric measurements made for 24 hours to see whether they had arrived at their steady state. **C. J. Robertson** thinks that the ultimate possibilities of carbon filaments have not yet been realised. **A. Russell** suggests that the ratio of the m.s.c.p. to the m.h.c.p. for carbon filament lamps can be calculated with sufficient accuracy for practical purposes by the formula $0{\cdot}785 + 0{\cdot}11(I_V/I_H)$, where I_V is the vertical c.p. and I_H the m.h.c.p. He also points out that appreciable errors

arise in practice owing to the reflections from the glass bulb containing the filament making the inverse square law not applicable. **L. W. Wild** says that he has found no difficulty in getting high-voltage standard lamps. He fails to see the utility of stopping a life test when the c.p. falls to 80 per cent. of its original c.p. An error of 1 per cent. in the last c.p. measurement makes an error of 10 per cent. in the "life" of the lamp. **H. T. Harrison** thinks that a metal filament lamp will be found a satisfactory standard of light. **W. E. Ayrton** showed the curves given by A. Kennedy at the Board of Trade inquiry in 1901 to illustrate the average efficiencies of 200-volt lamps. The efficiencies obtained were much higher than those obtained by the speaker or the author. He also gives the results of tests made in 1896 on lamps with silicon carbide filaments showing high efficiency and constant c.p. during their life. **A. P. Trotter** thinks the Hefner lamp the most suitable for making commercial tests. **W. R. Cooper**, whilst admitting that a test at the nominal pressure instead of the nominal efficiency introduces difficulties, thinks it a pity that a test at the nominal pressure cannot be introduced so as to make the tests conform more to working conditions. **J. T. Morris** suggests that when high accuracy is desired the flame of the standard lamp ought to be supplied with a very slowly ascending column of fresh air. **I. Howell** states that it is the standard practice of the General Electric and the B.T.-H. Co.'s of America to run lamps on life tests, so that results can be obtained in approximately 50 hours and upwards. **L. Gaster** thinks that lamp-makers should agitate so as to compel supply companies to keep the variations of their supply voltage within the Board of Trade limits. **T. A. Rose** states that the quality of a lamp depends quite as much on the vacuum in the bulb as on the quality of the filament. **J. S. Dow** insists on the importance of measuring the current through a lamp rather than the p.d. across it. He asks whether it is an established fact that a life test of a carbon filament lamp is the same with alternating as with direct currents. If so what is the limiting value of the frequency? In reply to a point raised in the *discussion*, the **Author** says that he has not been able to detect any variation of the c.p. of a glow-lamp with the temperature of the room [see Abstract No. 857A (1907)]. He has experimented on the effect of an alternating pressure with the low frequency of 25 on the lives of glow-lamps. Lamps were run with a direct pressure for a portion of their life and then changed over to the low-frequency alternating circuit. It was impossible to tell from the life curves when the change-over took place. A. R.

580. *Comparative Life Tests on Carbon, Nernst, and Tantalum Incandescent Lamps using Alternating Currents.* **H. F. Haworth, T. H. Matthewman, and D. H. Ogley.** (Inst. Elect. Engin., Journ. 38. pp. 850–866; Discussion, pp. 867–871, April, 1907. Electrician, 58. pp. 682–685; Discussion, p. 685, Feb. 15, 1907. Abstract. Écl. Électr. 51. pp. 35–38, April 6, and pp. 68–71, April 13, 1907.)—Part I. of the paper describes the authors' automatic field regulator, which is worked by a small continuous-current motor, actuated from the alternating voltage by a special relay, the latter being a modification of the drum cable relay of S. G. Brown [see Abstract No. 2357 (1902)]. The authors claim that this relay is, under normal conditions, capable of controlling the alternating voltage within ± 0·25 per cent. Details are given of the special connecting board adopted for carrying on several lamp tests simultaneously. The photometer equipment consisted of a Lummer-Brodhun photometer with a 2-c.p. Argand burner and Methven screen as a working standard. From the tests carried out with alternating currents, ½-amp.

Nernst lamps showed a saving of 57 per cent. in watts per c.p. over carbon lamps, but against this must be placed (1) the higher cost of the Nernst lamp, (2) its large size, (3) time taken to light up, (4) erratic life of the glower. In Part II. tables and curves are given of 230-volt lamps run on (1) constant normal voltage, for 1,000 hours, (2) 240 volts for 750 hours, (3) a voltage varying between 230 and 240 every 2 min. In each test of the Nernst lamps, an increase took place in the resistance of the glower, due to deterioration of its metallic contacts, and the faster this increase occurred the shorter the life of the glower proved. On normal voltage, carbon and tantalum lamps attained their maximum c.p.'s within 25 to 30 hours, their maximum currents being reached slightly later. Lamps of one make in which the c.p.'s attained the highest values in their group often fell off most rapidly, and were the lowest in value at the end of the test. The average watts per c.p. for the 70 carbon lamps tested was 4·36; for the 8, ½-amp. Nernsts 4·14; and for the 6 tantalum lamps, 1·97. The lives of the Nernsts averaged 560 hours, and of the tantalums 330. In the *discussion*, **C. C. Paterson** pointed out the difficulty of comparing the c.p. of Nernst with carbon lamps. Other speakers referred to the peculiar behaviour of tantalum lamps with alternating currents. **E. W. Marchant** gave results of comparisons between an Edison large-bulb standard and the Pentane lamp. H. F. H.

581. *Zircon-Wolfram Metallic Filament Lamp.* (Electrician, 58. p. 536, Jan. 18, 1907. Elect. Rev., N.Y. 50. p. 239, Feb. 9, 1907.)—A few particulars are given of this lamp, the invention of Zernig. Originally with a filament of zirconia, tungsten has been introduced in order to make it suitable for high voltages. Lamps are now made for 16 c.p. 100 volts, or 32 c.p. 200 volts. Tests at the Westminster Testing Laboratories showed, for a 35-c.p. 115-volt lamp, a consumption of 1·75 watts per candle at the start to 2·24 at the end of 1,000 hours. Later, continental tests with 65-c.p. 200-volt lamps have shown 1·38 watts per candle at the start and 1·28 after 500 hours. The lamp is being exploited by the Zirkon Syndicate, Ltd. L. H. W.

582. *Tungsten Lamps.* **C. Clerici.** (Atti dell' Assoc. Elettr. Ital. 11. pp. 137–148, March–April, 1907. Elettricità, Milan, 28. pp. 155–159, March 15, 1907. Electrician, 59. p. 281, May 24, 1907.)—Four principal methods of preparing lamp filaments from the non-ductile metal have been employed. The first is by obtaining it in the "colloidal state" by means of an arc under water. The resulting paste is squirted into a filament and afterwards heated. The second method is that of Just and Hanaman [Abstract No. 886 (1906)]. In the third method a powder of the metal is prepared by chemical means, mixed with an agglutinant and squirted into a filament which is then freed from carbon as before. The fourth method embraces various processes for preparing paste of oxide of tungsten which can be squirted in filaments and afterwards reduced. The author showed lamps made in Italy with filaments 0·05 mm. in diam. Such lamps require a length of 640 mm. for 110 volts and give 60 c.p. with a consumption of 60 watts. Experiments are in progress with filaments of 0·03 mm. diam., with which it is hoped to produce lamps of 110 volts 20 c.p. Numerous experiments show that a life of 500 to 700 hours may be counted on, while single lamps have run for 1,500 or even 2,500 hours. The resistance of one of these lamps (60 c.p., 110 volts) is 38 ohms cold and 170 ohms when hot. [See also Abstracts Nos. 215, 336, and 442 (1907).] A. E. L.

583. *Temperature and Light-emission of Carbon, Osmium, and Tungsten Lamps.* **A. Grau.** (Elektrotechnik u. Maschinenbau, 25. pp. 295–298, April 14, 1907. Écl. Électr. 51. pp. 250–252, May 18, 1907.)—The author refers to previous work on the subject and to the absence of uniformity in the results obtained. His own measurements of the temperature of the filaments of the lamps examined were made before he was aware of the work of Waidner and Burgess [Abstract No. 2024A (1906)]. The temperature was measured by comparing the filament with a glowing iridium plate whose temperature was estimated by means of a Wanner pyrometer, itself previously calibrated for "black body" temperatures. The results are given in the following tables:—

CARBON FILAMENT LAMP.

Product of length and diam. of filament = 15·5 mm².

Black Body Temperature in degrees C.	Amps.	Volts.	Watts.	Hefner Candles.	Watts per Hefner.	Hefners per 1 mm.² longitudinal cross-section.
1230	0·1580	57·5	9·085	0·2478	36·73	0·0159
1340	0·1823	58·0	10·572	0·6209	17·03	0·04006
1420	0·2020	64·5	13·029	1·257	10·36	0·081
1534	0·2409	77·0	18·549	3·121	5·943	0·201
1675	0·2790	89·0	24·831	6·815	3·643	0·439
1762	0·3440	111·0	38·184	23·69	1·61	1·52

TUNGSTEN LAMP.

$l \times d = 12{\cdot}675$ mm².

1208	0·9379	4·40	4·127	0·1428	28·91	0·01126
1334	1·0844	5·75	6·235	0·5304	11·76	0·0418
1410	1·1948	6·60	7·886	1·000	7·886	0·0788
1524	1·3897	8·40	11·673	2·882	4·05	0·227
1675	1·6222	10·95	17·762	8·477	2·095	0·669
1762	1·818	13·00	23·634	16·90	1·39	1·333

TUNGSTEN LAMP.

$l \times d = 10{\cdot}88$ mm².

1208	0·8184	4·50	3·683	0·1199	30·72	0·0110
1340	0·970	6·00	5.82	0·5122	11·36	0·0470
1420	1·0736	7·00	7·515	1·059	7·097	0·0974
1534	1·2397	8·85	10·971	2·864	3·830	0·263
1675	1·4111	11·00	15·522	7·182	2·161	0·660
1762	1·6825	13·55	22·120	17·30	1·28	1·59

OSMIUM LAMP.

$l \times d = 15{\cdot}64$ mm².

1200	0·9844	4·70	4·627	0·16	28·91	0·0102
1310	1·1370	5·91	6·720	0·5304	12·67	0·0339
1400	1·2816	7·18	9·202	1·059	8·69	0·0677
1524	1·5110	9·22	13·931	3·384	4·11	0·216
1657	1·7440	11·45	19·969	8·517	2·34	0·544
1762	2·0068	14·30	28·697	20·08	1·43	1·28
1850	2·2400	17·40	38·98	35·70	1·09	2·28

It is noticeable that the curve plotted between watts per Hefner and the temperature is identical for both the metal filaments. The carbon curve

lies above it for all temperatures up to 1,800 or 1,850° C., where it probably crosses the metal filament curve. But this is an impracticable temperature for carbon filaments. It is concluded that the higher economy of the tungsten lamp is due to the higher temperature of its filament. The brightness of a tungsten lamp at 1,850° C. (2,123° abs.) is three times that of a carbon filament lamp at 1,660° (1,933° abs.). Hence by Lummer and Kurlbaum's empirical law, $\phi_1/\phi_2 = (T_1/T_2)^x$, where χ approaches 12 above 1,900° abs., inserting the above values, if the author's figures are accurate the equation $(2123/1923)^{12} = 3$, should hold. The expression actually gives 3·07 L. H. W.

584. *Tungsten Lamps.* (Elect. Engineering, 1. p. 510, March 21, 1907.) —This is an abstract of patent, No. 15,021 of 1906 of the Consortium für Elektrochemische Industrie, in which a process is claimed by which the filament is heated almost up to its melting-point before being mounted in the lamp bulb. It is claimed that in this way the impurities are given off, and a stable condition is reached, suitable for a lamp taking about 1·5 watts per c.p. W. H. S.

585. *Tungsten Lamp Filaments.* (Brit. Pat. 4,814 of 1907.)—The Siemens and Halske A.-G. point out that filaments of tungsten powder which are prepared by pressing are wanting in durability and uniformity. The process here described consists in stamping tungsten powder, mixed or not with other metallic powder but without non-metallic agglutinants, in a tube of metal easily drawn or rolled, such as tantalum or iron, and then, after electrically sealing the ends, subjecting the tube to a drawing or rolling process. After completion of the drawing process the outer skin can, if desired, be removed. It is said to be possible to draw in this way, from a body a few cm. long and of about 5–10 mm. diam., a fine wire only a fraction of a mm. in diam. The method obviates the necessity for the great care in treatment involved in the fusion process. L. H. W.

586. *The Short Life of Frosted Lamps.* **E. P. Hyde.** (Elect. Rev., N.Y. 50. pp. 556–557, April 6, 1907. Communication from the Bureau of Standards, Washington.)—It has been known for a long time that the useful life of a carbon filament lamp in a frosted bulb is only a little greater than half what it would be in a plain bulb [see Abstract No. 642 (1906)]. By the useful life of a lamp is meant the number of hours taken for its c.p. to fall to 80 per cent. of its initial value. It might at first be thought that this effect was due to the higher temperature of the frosted lamp owing to the absorption of heat by the bulb. This probably has some effect on the useful life, but remembering that the whole life of the filament is practically independent of the nature of the bulb it is difficult to see how it could be the full explanation. The author suggests a much more plausible cause. The light emitted from a frosted lamp is more diffused than that coming from a plain glass bulb. A larger fraction of the flux of light in the frosted lamp passing through the inner surface of the glass is reflected back by the outer surface. There is thus a larger absorption of light due to the carbon continually being deposited on the inside of the bulb. The effect is the same as if the absorption coefficient for the frosted bulb increased more rapidly with time than the corresponding coefficient for the plain bulb. Hence the useful life of the former is the shorter although at any moment the flux of light coming from

the filament may be quite independent of the kind of bulb used. In order to measure this effect the m.h.c.p. and m.s.c.p. of ten practically new lamps and twelve old lamps that had completed their useful life were carefully measured. They were then carefully frosted in a uniform manner by the acid process and again measured. The new lamps were found to have decreased in m.h.c.p. by about 4 per cent. but the m.h.c.p. of the old lamps had decreased by 18 per cent. The apparent absorption by the frosting therefore was about 4½ times greater for the old lamps than for the new. This explanation accounts for a decrease of from 30 to 40 per cent. in the useful life. The new lamps had decreased in m.s.c.p. by about 4 per cent. but the old lamps had decreased by 20 or more per cent. This latter effect is probably due to the uneven distribution of the carbon on the inside of the bulb. In conclusion the author describes an elaborate experiment which has been planned and is being carried out to determine whether any other causes have an appreciable effect on the useful life of a frosted lamp. A. R.

587. *The Diminution of the Candle-power of Frosted Lamps.* **P. S. Millar.** (Electrical World, 49. pp. 798–799, April 20, 1907.)—An analysis is made of the causes of the diminution of c.p. with life of frosted lamps [see Abstract No. 642 (1906)]. The tests were made on 16-c.p. carbon filament lamps having a nominal efficiency of 0·32 candle per watt. A test was first made on the loss of c.p. due to the blackening of unfrosted lamps. The average results obtained were as follows :—

	Per Cent.
Absorption by glass and carbon deposit (new lamps)	5·0
„ „ „ „ (88 per cent. lamps)...	11·7
„ „ „ „ (80 per cent. lamps)...	15·7

By an 88 per cent. lamp is meant one the c.p. of which has dropped to 88 per cent. of its initial value. The average time taken by the group of lamps tested before their c.p. fell to 88 per cent. and 80 per cent. of their initial values was 324 and 470 hours respectively. Hence the loss due to increased absorption at 324 hours is 6·7 per cent., and at 470 hours it is 10·7 per cent. The loss in c.p. due to the deterioration of the filament itself was 5·8 per cent. at 324 hours, and 10·5 per cent. at 470 hours. The m.s.c.p. of groups of new 88 per cent. and 80 per cent. clear bulb lamps was accurately measured. The lamps were then acid-frosted and photometered again, with the following results :—

Average m.s.c.p. of sixteen new lamps—clear	13·4
„ „ „ „ „ —frosted	12·6
„ „ six 88 per cent. lamps—clear	11·6
„ „ „ „ „ —frosted	9·95
„ „ ten 80 per cent. —clear	10·6
„ „ „ „ „ —frosted	8·6
Loss of light due to frosting—new lamps	6 per cent.
„ „ „ —88 per cent. lamps......	14·8 „
„ „ „ —80 „ „	18·9 „

This proves that there is a loss due to frosting of 8·8 per cent. at 324 hours, and 12·9 per cent. at 470 hours. This is due to the carbon deposit absorbing a gradually increasing proportion of the light which the frosted surface reflects and diffuses internally. The loss of c.p. due to dust was next

investigated. After twenty frosted lamps had been burning 290 hours the following results were obtained :—

Average m.s.c.p. at end of test	9·88
„ „ after washing	10·74
Loss due to dust	6·7 per cent.

In a second test seven frosted lamps were burned for 886 hours :—

Average m.s.c.p. at end of test	8·4
„ „ after washing	9·5
Loss due to dust	10·5 per cent.

The dust factor depends largely upon local conditions, and varies with the length of time during which the lamp is exposed rather than with the hours burned. The experiments showed that the "80 per cent." life of the frosted lamps tested, the bulbs not being cleaned during the test, was 240 hours. The 20 per cent. loss from the initial c.p. is made up as follows :—

	Per Cent.
C.P. diminution due to change in filament	2·9
„ „ „ bulb blackening in unfrosted lamps ...	5·8
„ „ „ additional absorption by the carbon deposit of the light reflected and diffused by the frosting	6·5
„ „ „ dust on frosted bulb	6·8

This paper was written before the paper by E. P. Hyde [see preceding Abstract] was published. Where the results overlap they are in substantial agreement. A. R.

REFERENCES.

588. *Graphical Study of Division of Load between two Three-phase Lines in Parallel.* **G. Campos** and **G. Anfossi.** (Atti dell' Assoc. Elettr. Ital. 10. pp. 120–122, Sept.-Oct., 1906.) [See also Abstract No. 645 (1906).] A. E. L.

589. *High-frequency Surges in Continuous-current Networks.* **R. Hiecke.** (Elektrotechn. Zeitschr. 28. pp. 334–336, April 11, 1907. Écl. Électr. 51. pp. 171–173, May 4 ; 210–212, May 11, and pp. 247–248, May 18, 1907.)—The author criticises the conclusions arrived at by Feldmann and Herzog [Abstract No. 1329 (1906)]. A mathematical discussion of the problem is given, and the result arrived at that in any network containing armoured cables the damping due to the armouring is so powerful as to render strong surges impossible. The destruction of the lead sheathing in the neighbourhood of junction boxes is ascribed by the author to electrolytic effects, and not to high-voltage surges. A. H.

590. *Voltage Drop in Power Transmission Lines.* **C. F. Scott** and **C. P. Fowler.** (Elect. Journ. 4. pp. 227–233, April, 1907.)—Tables are given by the authors which allow of the calculation of the drop in various cases in a somewhat simpler manner than in the method proposed by Mershon [Abstract No. 407 (1907)]. A. H.

591. *Power Generation and Utilisation in Mines.* **H. Hoffmann.** (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1398–1404, Sept. 1 ; 1451–1462, Sept. 8 ; 1498–1505, Sept. 15 ; 1525–1540, Sept. 22 ; 1582–1586, Sept. 29, and pp. 1663–1668, Oct. 13, 1906.)—Forms a complete review of the subject, the chief feature being the numerous diagrams and plates illustrative of modern (continental) practice.

TELEGRAPHY AND TELEPHONY.

592. *Improvement in Quadruplex Telegraphy.* (Electrical World, 49. p. 781, April 20, 1907.)—J. C. Barclay's method (U.S. Pat. 848,221) of employing alternating-current dynamos for multiplex telegraphy is as follows: As many commutating rings on the armature shaft are used as there are circuits to be operated. Each ring is divided into conductive and non-conductive sections, two of each. The two conductive arcs are connected electrically, while the non-conductive arcs are dead. The brushes are so disposed in their relations to the insulated and conductive sections of the rings that one collects the positive currents and the other the negative. The positive current is used in operating one side of the quadruplex and the negative the other side, the corresponding receiving relays being so wound that one responds only to positive currents and the other to negative. When two or more circuits are connected to one machine, the commutating rings are so arranged on the shaft that no two circuits receive current pulsations at the same instant—that is, the positive pulsations, for instance, do not begin and end simultaneously. The lag is sufficient to allow a pulsation on one circuit to die out before the pulsation of the same sign passes into another circuit. By this method it is claimed that interference and mutilation of signals are avoided. E. O. W.

593. *Arrangement of Wireless Telegraph Apparatus.* D. McNicol. (Electrical World, 49. pp. 687–688, April 6, 1907.)—Chiefly concerning details of arrangement. The use of a spark "fattener" is advocated. According to the author this consists in placing a small insulated spiral of bare copper wire, about the sparking distance from the spark-balls, and in front of them so as to form a triangle with the latter. The placing of a 30,000-ohm non-inductive shunt to the detector (when of the carborundum or steel-carbon point type) is considered desirable, in that, although the minimum resistance is fairly constant the maximum resistance is not.

L. H. W.

594. *Improvements in Wireless Telegraphy.* (Brit. Pat. 25,490 of 1905. Engineer, 103. pp. 409–410, April 19, 1907. Abstract.)—This invention, patented by O. J. Lodge and A. Muirhead, relates to the employment of rectifying (unidirectional) vacuum valves for charging up the aerial structure, two such valves being shown connected in series in each lead of the coil or transformer circuit connected to the respective spark-balls. The object is to enable a small coil with rapidly-operating interrupter to sufficiently quickly charge up the aerials until the required discharge potential is reached.

L. H. W.

595. *The Telephone Repeater.* L. Cohen. (Electrical World, 49. p. 691, April 6, 1907.)—The author considers that inventors have failed to appreciate all the factors involved in the problem of repeaters. Effort has been directed to devise an instrument which shall reproduce and intensify the telephonic wave at some intermediary point on the line irrespective as to what may be the condition of the wave when it reaches that point. This idea, founded seemingly on that of the telegraph repeater, is not sufficient. There is no similarity between the two cases. In the telegraph line we are dealing with a single electrical impulse, and the main consideration in a repeater is merely

the intensification of that impulse, while in the case of telephonic transmission we are dealing with waves of definite shape and period. In order that we may have clear articulation at the receiving end, it is essential that the waves sent out at the transmitting end shall preserve their shape. It is well known that, in transmitting electrical periodic waves along a conductor, the velocity as well as the attenuation will depend on the frequency, and consequently the waves which are produced by the human voice and are complex in their nature will be distorted in travelling over a certain distance owing to the fact that the various harmonics will travel with different velocities and have different attenuation constants. The author then gives mathematical consideration of the question, and shows that the attenuation is a function of the frequency, and the velocity is also a function of the freqnency. Hence, every harmonic of any particular wave will have a different attenuation constant, and will travel with a different velocity; and after the wave has travelled an appreciable distance along the lines there will be a shift in phase between the various harmonics, which will produce distortion. Any repeater designed with the aim of merely reproducing and intensifying the wave as it reaches the repeater is sure to fail when tested on long lines, for even if a repeater could be designed that will reproduce exactly all the harmonics, it will still do nothing more than reproduce a distorted wave, and by the time the reproduced wave reaches the transmitting end it is still further distorted. In telephonic transmission it is not so much a question of intensity as of clearness. Heaviside, Pupin, and others have repeatedly called attention to the fact that to have good telephonic transmission we must have constant attenuation and constant velocity for all telephonic frequencies, and to produce these results Pupin has invented his loaded line, which certainly does accomplish the desired result, and so far this seems to be the only means of getting good telephonic transmission. It is very doubtful as to whether a telephone repeater will ever be designed which will take the place of the loaded line as Trowbridge seems to think [Abstract No. 789 (1906)]. Some inventors have to a greater or less extent considered the question of the variation of the attenuation-constant with frequency, and some efforts have been made to overcome this difficulty, but they have lost sight of the other factor—the variation of velocity with frequency. Therrell, for example, has developed a very interesting scheme for intensifying the harmonics at the transmitting end which will to a great extent overcome the difficulty arising from the difference in attenuation of the various harmonics [Abstract No. 1111 (1906)], but it does not eliminate or remedy in any way the distorting arising from the difference in the velocity of propagation of the various harmonics that enter into the composition of a telephonic wave. E. O. W.

596. *Improved Form of Telephone Cable.* (Brit. Pat. 1,889 of 1906. Engineering, 83. p. 469, April 5, 1907. Abstract.)—J. E. Kingsbury proposes a form of construction for telephone cables which has for its object the practical elimination of inductive disturbances. Each pair of wires forming a metallic circuit is twisted up so that the twist is of variable pitch, fluctuating periodically between a maximum and a minimum. In making up the twisted pairs into a cable, transpositions are effected at definite intervals (say every 200 or 250 ft.). The twisting of the wires in variable lays tends to break up parallelism between the conductors of adjacent pairs, while the transposition removes a pair from its position between two adjacent pairs before a sufficient amount of parallelism has developed to produce cross-talk. A. H.

SCIENCE ABSTRACTS.

Section B.—ELECTRICAL ENGINEERING.

JUNE 1907.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

597. *Test of a 4,000-h.p. Parsons Turbo-generator.* (Zeitschr. Vereines Deutsch. Ing. 51. pp. 676–677, April 27, 1907.)—The turbine was made by the Erste Brunner Maschinenfabriks-Gesell. for the Trzynietz Ironworks, and is coupled to a 3-phase, 50-∿ 3,100-volt Brown-Boveri generator. The turbine is for a normal output of 2,500 kw., and can be permanently overloaded by 10, and momentarily by 40 per cent. A brief account of a test, made by weighing the condensed steam, is given from which the following figures are taken. The low superheat is due to the fact that only a few of the boilers have superheaters as yet.

Load, kw.	Time.	Steam Pressure in atmos. abs.		Steam Temperature, °C.	Steam Consumption, kg.		
		At Stop Valve.	At Condenser.		Per kw.-hour.	Converted to 300°C. Superheat.	Guaranteed for 300° C.
No load (excited) ...	10.01 to 10.16	9·6	0·038	225	—	—	—
1,359·43	11.12 to 12.20	9·55	0·083	235	7·61	6·89	8·8
2,690	4 to 5	8	0·068	228	6·81	6·18	7·8

L. H. W.

598. *Recent Tests of Elektra Steam Turbines.* (Zeitschr. ges. Turbinenwesen, 4. pp. 229–231, May 29, 1907.)—Actual independent test results have not yet been published for sizes over 60 h.p. [Abstract No. 540 (1906)], although the makers' figures have been quoted [Abstract No 1072 (1905)]. In this article, besides several tests on smaller sizes, the results of a test by A. Stodola and J. L. Farny on a 300-h.p. compound turbine are given. The turbine is for a normal output of 200 kw. at 3,000 r.p.m., and has high- and low-pressure parts,

each provided with three velocity stages. Direct coupled to a 3-phase 2,000-volt generator, the test was made with the generator connected to a water resistance. The power required for condensing work was not measured, but the measured condensed steam included the amount which found its way through the Kolb type steam check glands.

	3-hour Test on Full Load.	40-min. on Overload.
Steam pressure (stop valve), atmos. above atmospheric	13·7	14·0
Steam temperature	295·7° C.	299° C.
Pressure in exhaust pipe, mm. of mercury	700·5	676
Barometer, mm.	752·0	749
Total condensed steam, kg.	6477·7	—
Leakage through glands, kg.	80·6	—
Electrical output, kw.	200·2	250·3
Steam per kw.-hour (excl. consideration of condenser pumps)	10·35 kg.	9·814 kg.

L. H. W.

599. *Present Practice in the Use of Superheated Steam.* **R. P. Bolton.** (Eng. Mag. 32. pp. 874–882, March, and 33. pp. 83–90, April, and 209–224, May, 1907.)—The author deals with the introduction of superheated steam and the study of its specific heat historically, showing that two elemental facts seem to be well established, viz., that specific heat increases with increasing pressure and stable temperature, but diminishes with increasing temperature and stable pressure. The most recent investigations by electrical methods conducted at Sibley College by Carpenter, Thomas, and Burgoon, indicate that sp. heat may not increase proportionally to increase of pressure to an indefinite extent, but that some modifications exist as higher pressures are reached. The final results are not yet published. Results obtained with superheated steam in steam jackets, and in cylinder work are reviewed, and their effects on fuel-draught and furnace-flue temperatures, and on condenser details and conditions, are indicated. The effects of superheated steam on systems for heating buildings, on steam pipes, joints, pumping engines, turbines, and locomotives are then dealt with; and the construction of superheaters is indicated with special reference to the desirable relations between gas and steam temperatures, several illustrations of superheaters being given. A bibliography of writings on superheated steam extending over a period of the last fifteen years concludes the series of articles. F. J. R.

600. *Experiences with Superheated Steam.* **G. H. Barrus.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 1457–1463, May, 1907. Eng. Record, 55. pp. 649–650, June 1, 1907.)—A number of differently equipped plants passed through the author's hands, commencing with a crude specimen having a cast-iron superheater at Massachusetts Institute of Technology in 1874, and various points of interest were brought out by their use. Nine plants are mentioned, and the results indicated are: The degree of superheating necessary to prevent cylinder condensation; Effect of condensed steam in the superheater where boiler and superheater were some distance apart; Leakage of superheater tubes from expansion; Burning of packing and efficiency of evaporation in boilers with superheaters. Condensation in cylinders was observed by means of a pyrometer placed in the cylinder with index outside indicating temperatures. F. J. R.

601. *Use of Superheated Steam in an Injector.* **S. L. Kneass.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 1455–1456, May, 1907.)—Experiments with saturated steam prove that the flow is in accord with the well-known formula based upon adiabatic expansion. The velocity of superheated steam is slightly higher since it follows the law of a perfect gas until condensation, due to expansion, commences; the velocity of the combined jet of steam and water would be increased, but this advantage is overbalanced by the shorter interval of contact and condensation, during which the additional heat in the steam must be abstracted. The practical effect is to reduce the maximum capacity, increase the minimum capacity, and to lower the limiting temperature of the water supply with which the injector can operate. To obtain good results it is necessary to modify the design and proportions of the tubes and nozzles. With high pressure and superheat an inefficiently designed instrument is inoperative. F. J. R.

602. *Flow of Superheated Steam in Pipes.* **E. H. Foster.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 1464–1467, May, 1907.)—From a number of installations it has been ascertained that the rate of heat-transfer per degree difference in temperature per sq. ft. of surface per hour increases with steam velocity; that this increase is more rapid in small than in large pipes; and that the percentage loss in heat decreases with the velocity notwithstanding the rising rate of heat transfer. A high velocity of superheated steam in pipes is therefore recommended because there is a lower actual drop in steam temperature—6,000 to 8,000 ft. per min., with a superheat of from 100° to 200° F. being indicated. Some plotted curves constructed from notes of results are given to illustrate these points and the following figures from O. Berner's paper [Abstract No. 1482 (1904)].

Loss of Temperature in deg. F. for 100 ft. of Pipe.

Average steam pressure 176·5 lbs. Average steam temperature 482° F. 105° F. superheat.

Diam. of Pipe (Inches).	Velocity of Steam in Feet per min.		
	1,968	3,936	5,904
3·937	50·3°	25·5°	16·45°
7·874	25·5°	12·7°	8·28°
11·811	17·0°	8·28°	5·49°
15·754	12·6°	6·07°	4·39°

F. J. R.

603. *Watching a Model Boiler at Work.* **C. H. Smith.** (Power, 27. pp. 284–285, April, 1907.)—Describes experiments with a model boiler of the inclined horizontal water-tube design, with a large mud drum at the lowest point of the rear end and two upper drums, one at the front end and one at the back, connected by horizontal tubes at the water-level and by steam tubes above. The inclined tubes of brass were connected to the mud and front drums and to headers connected with these. Glass ends in all the drums enabled observations of the action in them to be made. The model was worked up to 9 lbs. per sq. in. pressure. The phenomena of water circulation were studied, and the advantages of leading the steam to the surface of the

water in the front drum, and of the provision of a sufficiently large mud drum were demonstrated. The author also concluded that steam should be withdrawn from the rear upper drum and not from the front one as is usual. An illustration of the model boiler is given. F. J. R.

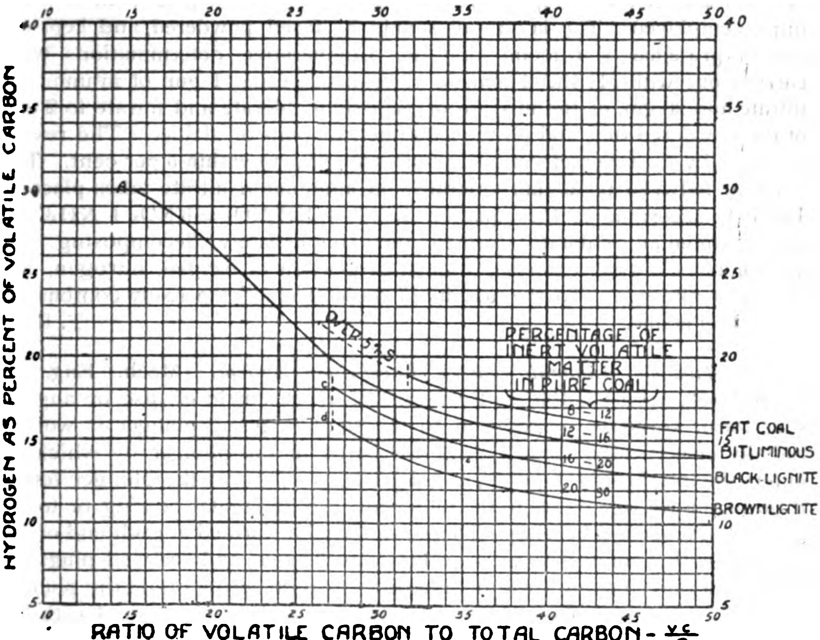
604. *Yarrow's Safety Device for Boilers.* (Mech. Eng. 19. p. 629, May 4, 1907.)—Instead of having fusible plugs in the bottom of a boiler over the fire, it is proposed to place a small pipe inside the shell having one end closed by being sealed to the shell by a suitable fusible metal. The other end passes through the shell and is furnished with a cock, or it may be led to an alarm or to a feed-pump. When the water falls below the safety-point the rise of temperature in the boiler acts in the usual way on the fusible metal, but the pipe being protected from the heat of the fire escapes injury, and when the cock is closed the boiler can be used for steam-raising without stoppage for insertion of a new plug. F. J. R.

605. *Kunert's Automatic Circulator Device for Boilers.* **Förster.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 641–646, April 27, 1907.)—The principle on which the device operates was outlined in Abstract No. 899 (1906). The author here gives results of tests of a large number of boilers, some fitted with the device and others without. The tables given in the original should be consulted. The use of these attachments is shown by the results to increase the boiler efficiency by from 1·19 to 8·4 per cent. The fuel used is also reduced by from 1·98 to 14 per cent., whilst the steam generated is increased by from 8 to 22·4 per cent. The results are discussed and a few exceptions explained. L. H. W.

606. *Determination of the Hardness of Waters.* **G. Magnanini.** (Gazzetta Chim. Ital. 36. 1. pp. 369–378, 1906.)—It has been stated that in determining the hardness of water by means of standard soap solution, the presence of small quantities of magnesia influences the accuracy of the results. The author has added varying amounts of lime, baryta, and magnesia to water and has then determined the hardness by means of soap solution in two different ways: (1) By shaking the liquid immediately after the addition of the soap solution; (2) by allowing a few minutes to elapse after each addition of soap solution and before shaking. It is found that, with waters containing either lime or baryta or the two together, the same results are obtained by the two methods of working. When magnesia is present, however, the second method alone gives accurate and concordant results. The reason of this is that the magnesia reacts slowly with the soap, and only when time is allowed for this to take place can a permanent lather be obtained. T. H. P.

607. *The Available Hydrogen of Coal.* **S. W. Parr.** (Amer. Chem. Soc., Journ. 29. pp. 582–589, April, 1907.)—The author describes in this paper an empirical method of determining the available hydrogen of coal, that is, the hydrogen over and above that required for combination with the oxygen present in the coal. The method is based upon the assumption that all solid fuels have been produced from the same raw material, and that cellulose, brown lignite, black lignite, bituminous coal, semi-anthracite, and anthracite represent the progressive stages in the changes that occur. Starting from this fundamental principle the author constructs a series of curves based upon

the relationship between the carbon of the volatile matter, the fixed carbon, and the available hydrogen for the different types of coal, and shows how, by use of these curves, the hydrogen can be calculated when the ratio of volatile carbon to total carbon has been ascertained.



The actual comparison of the figures obtained in this way for the available hydrogen of the fuel, with the figures obtained by the elementary analysis, and also the figures obtained by use of Dulong's formula, is given in the following table :—

	H From Curve.	H From Ult. Anal.	H From Ind. Calories.
Average of first 20 (Table No. 2)	3·39	3·28	3·42
Average of 50 from Bulletin No. 261, U.S. Geol. Survey	3·51	3·46	3·69
Average of 50 from report of Lord and Haas	3·96	3·95	3·90
Average of 12 from Mich. Geol. Survey	4·09	4·06	4·16
Average of first 20, as in Table No. 4 ...	3·30	3·17	3·29
Average of 70 from Bulletin No. 290, U.S. Geol. Survey	3·54	3·41	3·61

It is thus seen that out of 180 coals the extreme of error resulting from use of the curve is much within that resulting from the elementary analysis; and that the error is also less than that resulting from the use of Dulong's formula. J. B. C. K.

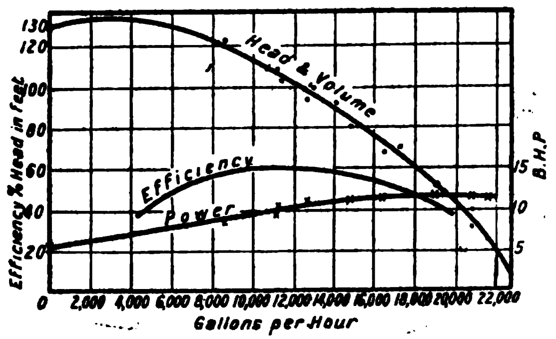
608. *Determination of Calorific Value of Lignite and Peat with the Lewis-Thomson Calorimeter.* **R. Salvadori.** (Gazzetta Chim. Ital. 36. 2. pp. 202–211, 1906.)—The calorific value of lignite, peat, coke, or anthracite cannot be accurately determined by the ordinary method of using the Lewis-Thomson

calorimeter, since these fuels are not completely burnt by the mixture of potassium chlorate and nitrate employed. If, however, 1 part of ammonium nitrate is added to the usual mixture of 8 parts of chlorate and 1 of nitrate of potassium, these fuels undergo regular and ready combustion. When 2 kg. of water are used, its temperature is raised 0·54° by each gm. of ammonium nitrate employed. The latter salt should be fused, powdered, and kept for use in presence of calcium chloride. Comparative determinations were carried out with (1) the Thomson calorimeter, using 1 gm. of ammonium nitrate and 20 gm. of the mixture of potassium chlorate and nitrate to 2 gm. of the powdered fuel, and (2) the calorimetric bomb of Mahler. The results obtained by the two methods were found to agree to within 5 per cent. The reaction between potassium chlorate and ammonium nitrate takes place at 123–124° according to the equation $KClO_3 + NH_4NO_3 = KNO_3 + NH_4ClO_3$, the ammonium chlorate formed then immediately decomposing into ammonium chloride, chlorine, a small proportion of oxygen, nitrogen, and oxides of nitrogen. To the activity of these products the ready combustion of the fuel is due. T. H. P.

609. *Tilston's Automatic forced Lubrication System.* (Mech. Eng. 19. pp. 552–553, April 20, 1907.)—By means of an eccentric of disc or angled-ring form, keyed or set-screwed to the shaft, a pump plunger is worked radially or vertically. Small holes are bored in the plunger by which oil enters the interior of the pump, and the inward stroke of the plunger forces it through a passage either to the underside of a horizontal bearing or to the top end of a vertical bearing. There is a chamber formed at each end of the bearing, with a connecting passage between the two, and screwed plugs for filling and for removing spent oil and dirt. A spiral spring inside the plunger makes its outward stroke and keeps the head of it always in contact with the eccentric surface. Woodcuts of sectional illustrations accompany the article. The apparatus is patented by the Forced Lubrication Co., Ltd., of Manchester, and is manufactured by G. Richards and Co., Ltd., Broadheath. F. J. R.

610. *Improved Indicator.* (Mech. Eng. 19. pp. 679–680, May 18, 1907.)—This indicator, which is due to B. Hopkinson, of the Engineering Laboratory, Cambridge, differs from both piston and diaphragm types of indicators in use, but combines some features of both types. A metal block, bored out along its axis and having a conical turned top, is screwed into the cylinder wall. At the upper end of the bore a small piston moves easily, the lower end of the bore being open to the interior of the engine cylinder. A frame with two upright branches or arms is held on the conical outside of the block so that it can turn upon the cone bearing without shake. The two arms of the frame carry a spring blade which stretches from one to the other and just clears the upper surface of the small piston. The frame also carries two vertical pieces of stiff spring in holes, at the upper ends of which a spindle carrying a mirror is pivoted. By means of a spring and a cross-piece the spring blade is connected to the pivoted spindle so that movement of the spring blade communicates a slight tilting motion to the mirror. The piston movement of the engine is given to the mirror by causing the frame to oscillate synchronously about the axis of the metal block through an angle proportionate to the piston travel. The pressure movement is obtained by the pressure of the small piston against the spring blade which deflects it vertically through a small distance proportionate to the pressure. The diagram is traced by a beam of light. In certain cases two mirrors are used to obliterate excessive vibration. F. J. R.

611. *Rees' "Roturbo" Centrifugal Pump.* (Engineer, 103. pp. 496–498, May 17, 1907.)—The defect in centrifugal pumps is found in the rapid increase of power required with any marked decrease in head and consequent loss of efficiency unless the speed be controlled, so that they are unsuitable for use with constant-speed motors. To remedy this defect and so enlarge their usefulness, the present design has been patented and introduced by E. S. G. Rees, of Thos. Parker, Ltd. In this design the rotor has a strong turbine effect, secured by making it of large capacity for storing water which is maintained by rotation at a practically constant internal pressure independent



of the external head. By an application of the Venturi law that pressure is transformed and utilised with little loss, instead of throwing away the surplus speed energy of the water discharged when the head of delivery is reduced, this energy is utilised, being reconverted into pressure before the water leaves the pump-casing. A constant-speed motor is able to drive this pump under wide variations of head and volume. Curves obtained from this pump are shown in the accompanying Fig., and it works satisfactorily even when delivering into a vacuum. Specimens are installed at the Dublin Exhibition for fountain displays, and at the Wolverhampton Borough Electrical Generating Station one is used for the circulating water of the condensing plant. The article is illustrated by photographs of the Wolverhampton installation, and by sections and elevations of a pump. F. J. R.

612. *A Constant-head Viscosimeter.* **F. B. Davant.** (Power, 27. p. 309, May, 1907.)—This instrument has been designed by the author, and is now in use in the oil-testing laboratory of the University of Tennessee. The specific claim made for it is that a constant head is maintained above the orifice, and that the oil can be held at any desired temperature either above or below 212° F. during the test. The principle of the instrument is that of maintaining a large volume of oil at the required temperature in a closed reservoir, and the control of the issue of this oil into that portion of the apparatus containing the orifice, by a vacuum and intermittent air admission. The air admission to the vacuum reservoir is regulated by a V-shaped opening between the two portions of the apparatus, which is alternately covered and uncovered by the oil in the run-off cylinder. This process goes on continuously, causing rapid pulsations from the reservoir, but maintaining in the run-off cylinder a head of oil that varies less than $\frac{1}{16}$ in. by actual measurement. J. B. C. K.

613. *Unctuous Graphite as Lubricant.* (Electrical World, 49. pp. 961-962, May 11, 1907.)—When the unctuous graphite of E. G. Acheson [see Abstract No. 153 (1907)] is ground up under water in a mortar, the particles settle again in a few min. When, however, tannic acid and a little ammonia are added, the black emulsion remains unchanged for weeks, and can be filtered without changing. Deflocculation ensues on further adding hydrochloric acid. The dried emulsion, rubbed on paper, shows the full lustre of graphite. Graphite first stirred with water and, after drying, ground up in oil, did not at first yield a good emulsion. Subsequent experiments were successful, however, and emulsions of unctuous graphite with water, light oils, or grease, are now recommended as lubricants. H. B.

GAS AND OIL ENGINES.

614. *Combined Internal Combustion Engine and Turbine.* (Mech. Eng. 19. p. 691, May 18, 1907.)—This combination is due to A. Büchi, of Winterthur, who has patented the arrangement. It consists of a series of eight 4-cycle cylinders disposed radially around a horizontal shaft, which also carries at one end the rotor of a turbine having several steps, and at the other end a turbo-compressor. The combination is illustrated by sectional elevations. The turbo-compressor delivers air at a pressure of several atmos. which, with or without admixture with the fuel, is cooled on its passage to the motor cylinders. Charges are compressed and exploded in the cylinders successively in the usual way, and the exhaust gases pass into a collecting chamber, from which they issue through converging nozzles to the blades of the turbine. F. J. R.

615. *Equations and Diagrams for the Chemical Changes in a Gas-producer.* R. Mollier. (Zeitschr. Vereines Deutsch. Ing. 51. pp. 532-536, April 6, 1907.)—The laws which govern the chemical and other changes taking place in a gas-producer are as follows: (1) The law of volume proportion relating to the chemical decompositions; (2) the laws of heat, from which a heat-balance can be constructed; (3) the laws of chemical equilibrium. The usual methods of studying the work of gas-producers are based upon (1) and (2), and it is only occasionally that an attempt is made to study the changes occurring within them in the light of the laws of chemical equilibrium. The author states that although methods (1) and (2) yield valuable insight into the working of gas-producers, there is scope for much work in the application of the third method; and that a most valuable check upon the efficiency of the producer will be obtained when the details of this method have been fully elucidated and it has been made available for general application. The remainder of the article is devoted to an analysis of the practical application of the three laws named above to producer-gas problems, and to the presentation of the results in algebraical and diagrammatic form. The original paper must be consulted if these equations and diagrams are to be adequately understood. J. B. C. K.

616. *Measuring and Testing Producer Gas.* R. Threlfall. (Soc. Chem. Ind., Journ. 26. pp. 355-374; Discussion, p. 374, April 30, 1907.)—By the methods which are described in previous papers [see Abstracts Nos. 2726 (1904), 1622A (1906)] for dealing with the velocity and density of gases flowing in pipes, observations of producer gas from Mond producers using

about 400 tons of coal per week have been made by the author for about four years. The measurements by stream gauges and by meter show substantial agreement. A curve of distribution of velocity for a 6-in. pipe attached to gasometer and a table of velocities at different pressures in mm. of water are given. The distribution of carbon in gas, ashes, dust, and tar, and the estimation of gas from a carbon balance, and by estimation of ammonia and by free nitrogen balance, are indicated; and the author's experiments on temperature estimations by means of thermo-couples are described, as are also those on continuous gas calorimetry, with specimens of the continuous calorimeter records obtained from Mond producer gas. The apparatus and processes employed in estimations of the sulphur and tar are next described, and the paper concludes with an account of experiments on the measurement of fluctuating and pulsating gas streams by means of Pitot tubes and meters. In the *discussion*, **A. H. Lymn** referred to the importance of standard methods of continuous calorimetry and tar estimation for power-gas users. **H. G. Colman** and **R. J. Friswell** referred to the importance of measuring the air entering producers, and the **Author**, in reply, stated that his earlier experiments, recorded in the previous papers referred to, had been made on streams of air produced by fans. F. J. R.

617. *Measurement of Gases by Pressure Variations.* **E. Stach.** (Stahl und Eisen, 27. pp. 618–628, May 1, 1907.)—The author discusses the measurement of the volume of the waste gases from blast-furnaces and other metallurgical processes, of which in Germany at present only about 875,000 h.p. (a mere fraction of the total) are utilised in gas engines. The only practicable method of measuring the volume of these gases is that based on the difference of pressure observed with accurate manometric apparatus; and from this the speed of the gases as they pass the point where the test is made can be deduced. A recording apparatus based on this principle has been devised by P. de Bruyn, and is being widely adopted in German ironworks for measuring the volume of the waste gases. An illustrated description of this apparatus and of the records obtained with it are given—the latter are expressed in metres per sec., and from the record for 12 hours the volume of gas passing the point where the test is made can be accurately calculated. When these waste gases are employed for steam-raising purposes, or for power generation in gas engines, the record is again useful for calculating the boiler or engine efficiency. The records reproduced in the original article from actual tests with the apparatus are of (1) blast-furnace gases, (2) coke-oven gases, (3) gases in the supply pipe of a gas engine. J. B. C. K.

618. *Determination of Dust in Blast-furnace Gases.* (Power, 27. pp. 331–333, May, 1907.)—The author states that furnace-gases ought to be freed as far as possible from dust before use either in internal combustion engines or in the stoves of blast-furnaces. The dust and dirt in the uncleaned gases amount to from 12 to 30 gm. per cub. m. (equivalent to 5 to 13 grains per cub. ft.), whereas a thoroughly cleaned gas will contain only 0·02 gm. of dust per cub. m. (0·009 grains per cub. ft.). As 75 per cent. of the dust in the uncleaned gases is metallic oxide, and is gritty, it forms a very destructive abrasive in the cylinders of gas engines unless removed. The apparatus for determining the amount of dust generally employed depends upon the filtration of the gas through cotton-wool. This method is inaccurate, and the author has substituted for cotton-wool, filter-paper with good effect. The

circle of filter-paper is dried at 212° F., weighed and clamped as a diaphragm in a flat brass box provided with inlet and outlet pipes. The gas is drawn through this filter-box and also through the recording meter, which is connected in series with it by any of the usual methods. The filter-paper at the end of a stated time is removed from its holder, dried at 212° F., and reweighed. The increase in weight in grains divided by the cub. ft. of gas aspirated through the apparatus gives the grains of dust per cub. ft. Absorbing tubes containing $CaCl_2$ may be added to the apparatus to absorb moisture if desired. As the moisture has a tendency to choke up the pores of the filter-paper, it is advisable to keep an incandescent lamp or candle burning below the brass box, in order that the box and the diaphragm of filter paper may be kept warm. A wire gauze support may be also used beneath the filter-paper to prevent risk of breakage during the test. J. B. C. K.

619. *Liquid Fuels and their Utilisation fot Gas Engines.* **K. Kutzbach.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 521–527, April 6, and pp. 581–586, April 18, 1907. Paper read before the Rheingau Bezirksverein.)—The author in this lengthy paper discusses the various methods by which liquid fuels can be converted into explosive gaseous mixtures and employed for driving gas engines, and then deals with the thermal side of this problem, and the conditions which must be observed in order to attain the highest possible efficiency from the fuel in the engine. Three methods of converting the liquid into an explosive gaseous mixture are in use, namely, vaporisation of the liquid by heating outside the engine cylinder, vaporisation by means of the heat of the waste gases as it enters the cylinder, and vaporisation by mechanical means. Eight examples of these three methods are given. The dangers of pre-ignition of the gaseous mixture during compression are discussed, and it is pointed out that the Diesel motor is the only one which avoids this grave difficulty by compressing the air alone, and only admitting the vaporised oil when the charge is ready for ignition. By operating in this way compressions of 30 to 40 atmos. become practicable, and perfect combustion of the fuel is secured. The remainder of the paper contains figures showing the rapid progress of the Diesel motor since its introduction in the year 1898. The Vereinigte Maschinenfabrik Augsburg and Maschinenbaugesellschaft Nürnberg have increased their annual output of Diesel motors from 42 to 526 in this period, and the total h.p. of these motors has risen from 450 to 19,800 in 1906–7, the average size of motors having increased in the same period from 23 h.p. to 68 h.p. Comparative figures are given for a suction gas-producer plant and a Diesel motor, and the advantages of the latter up to 100 h.p., both in cost of running and in ground space are clearly set forth. The application of the Diesel motor to ship propulsion is finally discussed, and a 145-h.p. motor running at 375 r.p.m. built for this purpose is described. Four similar motors of 300 h.p. each are now being built for the French submarines. J. B. C. K.

620. *Test of a 12-h.p. Alcohol Semi-portable Engine.* **K. Schleip.** (Gasmotorentechnik, 7. pp. 5–10, April, 1907.)—The engine is used to drive a threshing machine, and has a single cylinder of 250 mm. bore, 320 mm. stroke, 200 r.p.m., 15·69 litres piston displacement, and 2·41 litres compression space. One of the two flywheels, 1,500 mm. in diam., is used as a belt pulley. The alcohol is supplied through a pulveriser, due to the action of the air passing through at 90 m. per sec., by which it is projected against a gauze strainer. The alcohol supply valve is regulated by the opening of the admission valve, so that at low loads both less air and less alcohol are admitted.

Cooling of the cylinder is effected by a water tank which is filled once for all. The air supply is heated by being made to pass along the exhaust pipe. Tests of the fuel consumption at various loads were made with alcohol of 85·9 per cent. (by weight), and of calorific value 5,500 kg.-cals ; also with benzol alone and mixed with the alcohol, which brought the calorific value of the mixture up to 6,100 kg.-cals. The tests were made with two balanced Brauer brakes.

<table>
<tr><td>Load, b.h.p. ....</td><td>15·8</td><td>12·7</td><td>10·0</td><td>8·75</td><td colspan="2">7·5</td><td>6·4</td></tr>
<tr><td>Alcohol, gm. per h.p.-hour</td><td>858</td><td>876</td><td>895</td><td>425</td><td colspan="2">465</td><td>512</td></tr>
<tr><td>Benzol " "</td><td>828</td><td>841</td><td>856·5</td><td>383</td><td colspan="2">415</td><td>463</td></tr>
<tr><td>Thermal effcy. for alcohol</td><td>32·1</td><td>30·6</td><td>29·2</td><td>27·1</td><td colspan="2">24·7</td><td>22·4</td></tr>
<tr><td>" " benzol...</td><td>32·0</td><td>30·4</td><td>28·5</td><td>27·0</td><td colspan="2">25·0</td><td>22·4</td></tr>
<tr><td>End compression pressure, kg./cm.²......................</td><td>13·9</td><td>12·8</td><td>10·7</td><td>9·25</td><td colspan="2">7·7</td><td>6·5</td></tr>
<tr><td>End explosion pressure, kg./cm.²........................</td><td>31</td><td>26</td><td>22</td><td>20</td><td colspan="2">17</td><td>14</td></tr>
<tr><td rowspan="2">Percentage of total output consumed in losses.........</td><td rowspan="2">0·9</td><td rowspan="2">1·5</td><td rowspan="2">2·1</td><td>b.h.p. 8·5</td><td>6·3</td><td>4</td><td>no load.</td></tr>
<tr><td>4·6</td><td>10·2</td><td>18</td><td>45</td></tr>
</table>

The rapid increase in the losses at light loads shows that the hit-and-miss regulation is best at such loads, since the combustion cannot be equally well regulated by the method of varying the quantity of mixture. L. H. W.

621. *Utilisation of Tar-oils for the Diesel Motor.* **P. Rieppel.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 613–618, April 20, 1907. From Mitteilungen über Forschungsarbeiten des Vereines. Extract. Engineering, 83. pp. 782–783, June 14, 1907.)—The difficulty of providing oil at a low price for the Diesel motor has caused a set-back in its application for power purposes in Germany, since, owing to the increased price of the more suitable oils, the cost of power generation by the Diesel motor approaches or exceeds that of other prime-movers. The investigation, of which details are given in this paper, was undertaken to show how far other and cheaper classes of oils are applicable to the purpose of driving the Diesel motor. Two classes of oils were experimented with, namely, oil from the dry distillation of lignite and oils obtained from the dry distillation of ordinary bituminous fuel. The results obtained are summarised by the author as follows: 1. Lignite tar oils are applicable, coal-tar oils are not applicable for the purposes of the Diesel motor. 2. For judging of the suitability of an oil, the usually ascertained values: sp. gr., viscosity, ignition or flash-point, combustion temperature and calorific value are of no utility. 3. On the other hand, the percentage of hydrogen as ascertained by the elementary analysis is of the highest importance, since this indicates the presence or absence of certain of the fatty and aromatic series of hydrocarbon compounds. 4. The ignition and combustion temperatures of the oil are of use, however, as an indication how easily the oil may be converted into gas. It is to be noted in this connection that coal-tar oils require a greater heat and a longer duration of the heating period than lignite-tar oils. 5. All liquid-fuel motors may be divided into two main classes : (1) Those in which the oil is sprayed into the motor when the piston is at its dead point, and in which no artificial ignition is required, and (2) those in which a mixture of oil vapour and air is artificially exploded. It has been possible, by applying heat to the

compression chamber of the Diesel motor, to utilise successfully anthracite and creosote oils for the purpose of driving it. A Diesel motor, of which the design has been modified to render this possible, has been running for some weeks at the Nürnberg factory with cheap coal-tar oil as driving material, and the running costs for fuel have been only 0·8 Pf. (0·094d.) per h.p.-hour.

J. B. C. K.

622. *H.P. of the Petrol Engine in Relation to its Bore, Stroke, and Weight.* **F. W. Lanchester.** (Automotor Journ. 12. pp. 657–658, May 11, 1907. Abstract of paper read before the Inst. of Automobile Engin., April 10, 1907.)—The author commences by pointing out that if the same materials are used in every case for like parts the power varies simply at the square of the linear dimensions, and that the weight per h.p. of similarly designed engines varies inversely as the linear measurement; he also points out the liability of any rating rule to lead to distortion in design. The influence of the specific strength of the materials used is discussed, and reference made to the fact that an increased number of cylinders permits a lesser weight on the fly-wheel. The author shows that: (1) The h.p.-rating rule must obey the L^2 law—that is to say, must be based on a quantity of the dimensions $= L^2$. (2) That if based upon the two linear quantities, diam. D and stroke S, it must be of the form D^nS^{2-n}, where the appropriate value of n deduced from mechanical considerations is from 1·5 to about 1·6. Departures from (1) lead to distortion in the direction of an increase or decrease, as the case may be, in the number of cylinders; where the index is in excess of 2 it pays to increase the number of cylinders to the highest possible limit, and *vice versâ*. Departures from condition (2) lead to a distortion in the proportions of bore and stroke. When the value of n is increased it pays to build long-stroke engines; when the value of n is decreased the short-stroke engine has the advantage. So long as the value of n is chosen between the limits given, it is doubtful whether a designer could obtain any material advantage by adopting extreme proportions. Taking everything into account, the simpler form of expression appears the more desirable, *i.e.*, H.P. varies as $D . \sqrt{D} . \sqrt{S}$ or $\sqrt{D^3 . S}$. The author then gives the formula $\text{H.P.} = C \sqrt{D^3S}$, and proceeds to discuss the value to be assigned to the constant C. In the case of the Otto cycle, where D and S are given in inches C may be taken as 0·4, giving an ordinary maximum b.h.p. value. For other forms of internal combustion engine appropriate values of C may be obtained, based upon the cylinder pressures ordinarily attained in the particular cycle employed and the frequency of the impulses. With regard to steam cars, if the proposed rating is applied, the constant C should be made proportional to the boiler pressure. It is suggested that, in view of the doubt that at present exists as to the extent of the influence of size of cylinder on mean pressure, it is dubious whether anything material is gained by introducing this factor into the rating expression. Another un-accounted factor is that introduced from considerations of mechanical efficiency. In general we are accustomed to expect the mechanical efficiency of a large engine to be better than that of one of small size; it is doubtful whether this is well founded.

W. P. D.

623. *Electrical Ignition Methods compared.* **F. W. Springer.** (Electrical World, 48. pp. 995–998, Nov. 24; 1111–1115, Dec. 8, and pp. 1242–1248, Dec. 29, 1906.)—A lengthy theoretical and oscillographic examination of the action in the break-spark method and the discharge or jump-spark

method; the oscillograms serve to trace the effect of varying certain factors. No very definite results are arrived at. The jump-spark (trembler coil) is held to be less efficient, but, on the other hand, its spark has greater disruptive and detonative properties than the break spark; the igniter lag is also usually less. [See also Abstract No 496 (1907).] L. H. W.

REFERENCES.

624. *Combining Superheater with Thermal Storage Vessels.* (Brit. Pat. 8,530 of 1906. Engineering, 83. p. 602, May 3, 1907. Abstract.)—The superheater of J. Cowan and A. J. Fuller—which in the illustration is, like the boiler, of the Stirling type—is provided with a stand-pipe with branch leading to the main steam-pipe. A portion of the superheated steam ascends to the thermal storage vessels placed above, into which the feed-water is led by one pipe and from which the hot water is led to the boilers by another pipe. F. J. R.

625. *Electrical Indicator for Water Tanks.* (Elect. Engin. 39. p. 605, May 3, 1907. From "Engineering and Mining Journ.")—The float carries a lever which works a segmental arm across a series of contacts, incandescent lamps being switched into parallel one after another as the float rises. The current taken by these lamps is recorded on one or more ammeters, which can be calibrated to read in feet the depth of water in the tank. H. F. H.

626. *Modern Water-wheel Testing.* **C. M. Allen.** (Eng. Record, 55. pp. 162–168, Feb. 9, 1907.)—Illustrated description of cast-iron disc Prony brake form of dynamometer which can be counterbalanced so that its weight is entirely removed from the bearings, used at the Holyoke Testing Flume. The capacity is 3,000 h.p., but 4,100 h.p. has been absorbed at 225 r.p.m., and 2,300 for 8 hours continuously.

627. *Petrol-electric Transmission for Road Vehicles.* **E. W. Hart** and **W. P. Durtnall.** (Elect. Engin. 39. pp. 120–124, Jan. 25, and pp. 154–156, Feb. 1, 1907. Paper read before the Soc. of Motor Omnibus Engineers, Jan. 21, 1907. Automotor Journ. 12. pp. 118–119, Jan. 26, and pp. 152–154, Feb. 2, 1907. Electrician, 58. pp. 614–616, Feb. 1, 1907. Abstract.)—The different better-known types of petrol-electric or mixed transmission are dealt with and the chief features illustrated; these are all continuous-current systems. The Hart-Durtnall system employing polyphase current [see Abstract No. 1140 (1906)] is then described at greater length, a diagram of the connections being given besides other illustrations. L. H. W.

628. *Motor Omnibuses.* **Montagu.** (Soc. Arts, Journ. 55. pp. 374–381; Discussion, pp. 381–385, Feb. 15, 1907.)—A popular account of the present state of the motor omnibus service in London. Costs per mile, actual and probable, are quoted from Crompton's paper read recently before the Institution of Civil Engineers, and the results are compared with those obtained on the London County Council's tramways, to the detriment of the latter. W. R. C.

629. *J. Hofmann's Flying Machine.* **A. Gradenwitz.** (Scientific American, 96. pp. 252–253, March 23, 1907.)—Illustrated.

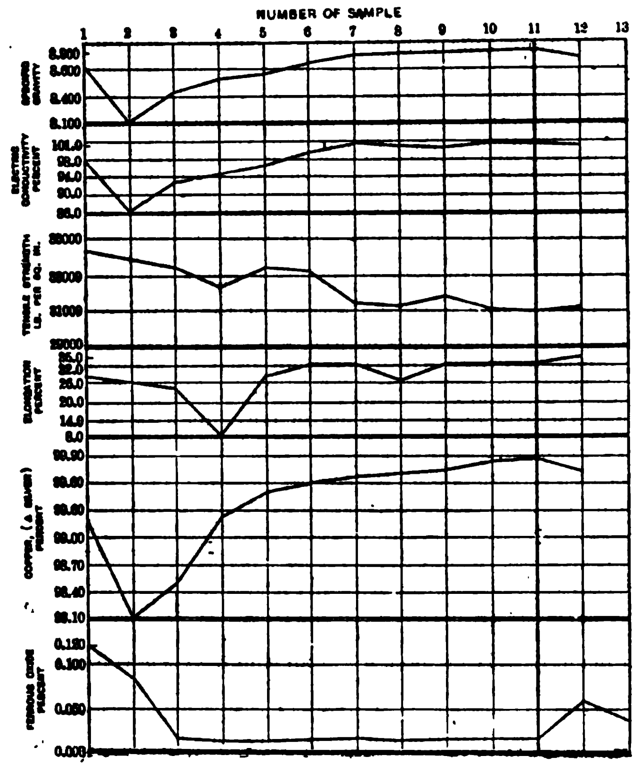
INDUSTRIAL ELECTRO-CHEMISTRY, GENERAL ELECTRICAL ENGINEERING, AND PROPERTIES AND TREATMENT OF MATERIALS.

630. *Capacity of Planté-formed and Pasted Positives on Interrupted Discharges.* **R. Albrecht.** (Elektrotechn. Zeitschr. 28. pp. 539–541, May 23, 1907. Dissertation, Hannover, 1906.)—The author investigates the difference in the behaviour on discharge of cells having Planté and pasted positives respectively. Three cells of each sort were used, having each, apparently, a single positive plate of 1 dm.[2] surface (one side). The negatives were chosen so large as to warrant the conclusion that these were uninfluential as regards the final voltages. The results are set out in tabular form, and in curves, of three discharges, at 2, 1·5, and 1 amp. respectively without interruptions, and a second set of three discharges in the course of which the current was interrupted several times for some hours. The curves show a marked difference between the Planté and the pasted plates; and [so far as it can be accepted as capable of being established with such small cells and so few of them, with so few discharges, and such a bad disposition of the plates] the author concludes that while the Planté plates after a period of rest show no noticeable increase of capacity, such an increase of capacity is very marked in the case of the pasted plates, and may amount to 25 per cent.; and is greater the greater the discharge rate. The effect is attributed to self-discharge on the part of the Planté plates during the periods of rest. L. H. W.

631. *Gardiner's Storage Battery.* (U.S. Pats. 827,861 and 827,968. Zeitschr. Elektrochem. 13. pp. 172–174, April 26, 1907. Abstracts.)—In the first of his patents W. Gardiner proposes to place two electrodes (not more) horizontally in a box-cell of copper. The negative active material lies at the bottom between sheets of wire gauze. The positive electrode is fixed on an insulating support and consists of two sheets of perforated metal Ag, Ni, or Cu, holding a slab, which may be subdivided by bolted bars, of an alloy of finely-divided Ag and Ni. The electrolyte, caustic alkali saturated with $Zn(OH)_2$ or $Cd(OH)_2$, is filled in through a charge hole in the top of the cell; the hydroxides settle in the space between the wire-gauze sheets. In the second patent the arrangement is vertical. The positive electrodes are surrounded by wire gauze of silvered copper; the electrolyte is sulphuric acid and an aqueous solution of $ZnSO_4$, Li_2SO_4, $HgHSO_4$. Zinc and mercury are to be deposited on the wire gauze, and the lithium is to prevent self-discharge. The lead container case forms the negative electrode. The cells are said to bear concussions well. H. B.

632. *Electrolytic Copper.* **H. O. Hofman, R. Hayden, and H. B. Hallowell.** (Amer. Inst. Mining Engineers, Bull. 14. pp. 275–299, March 1907.)—The authors have carried out a lengthy experimental investigation to determine the effects of refining upon the physical and chemical properties of electrolytic copper, and especially of the changes produced by over-poling. The physical changes considered were: appearance of

surface, specific gravity, tensile strength, elongation, and electrical conductivity. The chemical changes noted were: variations in the copper, iron, sulphur, and oxygen contents. The following diagram contains the results of the first investigation :—



The results may be summarised as follows: The percentage of copper rises quickly at first during the refining operation at about the same rate as the cuprous oxide is reduced. Later it increases more slowly since it becomes more difficult to reduce the small amount of remaining cuprous oxide. The amount of ferrous oxide present in electrolytic copper is very small, any excess over a minimum varying with different charges is quickly eliminated. The sulphur content of electrolytic copper remains practically unchanged by fire-refining. The sp. gr. and electrical conductivity rise and fall with the copper content; cuprous oxide has an effect opposite to that of copper. The tensile strength decreases as the reduction of cuprous oxide progresses, but the corresponding increase in elongation is not shown so clearly by the curves as would be expected. As regards the study of the effects produced by over-poling, the authors' conclusions are as follows: The evidence obtained relating to the oxygen, sulphur, and iron contents of furnace over-poled electrolytic copper, and to the effect of temperature permits of various interpretations. It has been clearly proved, however, that copper absorbs H, CO, and SO_2, and that the solubility increases with the temperature and decreases with the oxygen content. With set copper the solubility is at a minimum and set copper solidifies with a depressed

surface. With crucible over-poled copper the solubility is at a maximum, on account of the necessarily high temperature and the entire absence of oxygen, and the copper solidifies with a "crowned pitch." Between these two extremes lies the "level set" or proper "pitch" of tough-pitch copper, for the object of refining is to obtain a metal which will have the highest attainable degree of malleability, ductility, and electrical conductivity, and present at the same time a level surface when it solidifies in the mould after casting. J. B. C. K.

633. *Electrolytic Manufacture of Seamless Copper Tubes.* **E. Krause.** (Zeitschr. angew. Chemie, 20. pp. 305–308, Feb. 22, 1907. Metallurgie, 4. pp. 255–256, April 22, 1907.)—The author describes a new method for obtaining dense and homogeneous deposits of electrolytic copper upon a revolving mandrel, this method being now employed at the works of Langbein and Co., Leipzig, with success. The method depends upon the use of siliceous matter suspended in the electrolyte, a sufficient quantity of this being used, to act as an attrition agent upon the surface of the deposited copper, and to remove all bubbles of hydrogen as well as to give density and smoothness to the deposited copper. The electrolyte used is made up of a copper sulphate of 22° Bé, with an addition of 5 kg. of sulphuric acid and 20 kg. of quartz per 100 litres of liquid. The mandrel may be of polished brass, coated with shellac, by painting it with a solution of 8 parts of shellac in 100 parts of 96 per cent. alcohol. The covering is then rubbed over with graphite to render it conducting. The best results, however, were obtained with a mandrel of iron coated with nickel, since the deposited tube was easily removed from this core. The speed of revolution is only low, 20 r.p.m. being found sufficient to obtain the necessary degree of friction between the suspended materials and the face of the kathode. In the Leipzig works copper tubes 2 m. in length, 14 to 20 cm. in diam., and 5 mm. thick, have been made by this method, using an e.m.f. of 2·5 volts and a current density of 2 amps. per sq. dm. The surface of these tubes was smooth and metallic in appearance and showed no excrescences. As regards mechanical strength, independent tests have shown that this is twice as great as that demanded by the German marine authorities for copper tubes, and that the strength is increased by drawing down the tubes to smaller diameter. The advantages of the new method are, therefore, smooth and dense deposits at a low rotation velocity of the mandrel and a product that can be employed for high pressures. This new method of producing seamless copper tubes by electrolysis is covered by German Patents Nos. 175,470 and 125,404. The method can be applied to the production of plates and tubes of any metal that is liable to be deposited in a spongy or porous state by the electrolysis of solutions of its salts. J. B. C. K.

634. *Aussig Glocken Process for Alkali Chloride Electrolysis.* **O. Steiner.** (Electrochem. Ind., N.Y. 5. pp. 171–172, May, 1907.)—Describes an electrolyser of the "bell" type, in which the chlorine liberated at the anode within the bell is led away in the gaseous form. A vertically suspended anode of graphite within the porous earthenware bell (which does not reach to the bottom of the cell) with external kathodes is employed. The incoming electrolyte of potassium chloride is fed in as the anode is introduced into the anode compartment, being distributed very uniformly over the whole anode surface, the formed kathode solution being removed by a simple overflow pipe. The author critically examines the usually accepted theory of the process, based

apparently on claims in patent specifications, which is to the effect that the incoming electrolyte moves downwards with the same speed that the OH ions move upwards, and that consequently there exists in the same place a separating medium of neutral liquid between the anolyte and katholyte. After pointing out that the rate of ionic migration of the OH ions takes place at six times the speed of the downward moving electrolyte, the author puts forward the explanation that if the liquid around the anode be kept continuously saturated with the chloride undergoing decomposition it is possible to prevent the OH ions from reaching the anode, provided that there is no disturbing circulation of liquid within the bell. Dealing with the cell as in practical operation, the anode is made so large that it fills almost completely the whole horizontal cross-section of the cell. The author points out that in addition it is necessary that the upper surface of the anode should be absolutely level and horizontal, as otherwise a stream of higher sp. gr. will flow from the lowest point on the anode surface without proper distribution and thorough mixing. No specific details of the performances of the cell as to voltage, electrochemical efficiency, and amount of unconverted chloride in outflow are given, but reference is made to a loss on large installations of 6 per cent. of the evolved chlorine due to the formation of hypochlorite between the chlorine and the hydroxide in the katholyte.

W. P. D.

635. *Electrolytic Hypochlorite Solutions for Bleaching Paper-pulp.* **W. P. Digby.** (Electrochem. Ind., N.Y. 5. pp. 178–182, May, 1907.)—The author first discusses some of the conditions affecting the success or otherwise of electrolytic methods of bleaching paper-pulp. These are: (*a*) The conditions of the pulp prior to bleaching. (*b*) The rapidity of action. (*c*) The final colour obtained. (*d*) Effect of bleaching medium on the paper produced. For measuring the cleanliness of the pulp he proposes a colorimetric method, depending upon comparison with a brown aniline dye solution contained in a wedge-shaped prism. As regards rapidity of action he states that electrolytically-prepared sodium hypochlorite is more rapid than the chemically-prepared salt, and both of these more rapid than calcium hypochlorite. The final colour attained by the pulp is at present unsatisfactorily recorded by such terms as "good," "not up to mill standard," &c., and the author suggests in place of these terms a scale based on the use of numbered pieces of glazed white china differing in whiteness. Two series of tests were carried out, using esparto grass as it was delivered from the boilers, the one series being on a laboratory scale of operations, and the other in a paper-pulp factory. Detailed figures of these tests, and diagrams showing the fall in strength of the hypochlorite solutions as the bleach proceeded, are given in the original. The results obtained are summarised as follows: *Small Scale Tests.*—The best results as regards colour and quantity of Cl required were obtained with the solutions of high Cl content, and when the water carried by the material under treatment was reduced to a minimum. *Large Scale Tests.*—The best results were obtained when the Cl content of the potcher had the highest value, immediately upon the completion of adding the bleaching solution. Too low a Cl strength, even if maintained for a longer time, fails to give the same degree of whiteness, as a higher initial Cl strength. Comparing the results obtained from electrolytic hypochlorite with those obtained from chloride of lime, the author states that the bleaching action of 1 grain of Cl in the former is equal in intensity to 1·52 grains of Cl in the latter, that a temperature 10° F. lower can be employed, and that the action of the electrolytic solution is

much more rapid. He explains this difference in bleaching efficiency by stating that the electrolytically prepared hypochlorite molecule is less stable in the presence of organic matter, and acting with greater rapidity suffers less loss through actual disintegration and decomposition of the esparto fibre. The final section is devoted to the consideration of *costs*. The application of the electrolytic method of bleaching paper-pulp in any mill must be considered in the light of local conditions, and a reduction in the amount of salt required for the cell is one of the necessary conditions of success. The author states that the initial strength of available Cl within the potcher need not exceed 350 grains per cub. ft., and that with pulp free from excessive moisture, solutions containing from 3 to 4 gm. of available Cl per litre will suffice to attain this strength. Such solutions can be produced in the electrolytic cell with high electrochemical efficiency. Finally, the author urges that each case should be studied separately, and that it is unwise to apply the figures obtained for one mill to the perhaps utterly different conditions obtaining in another. The investigations which he has conducted both in the laboratory and the factory lead him, however, to believe strongly in the possibilities of the electrolytic hypochlorite processes for bleaching textiles and paper-pulp. [Author's Corrigendum: In Tables on pp. 179 and 180: *for* total grains available Cl, *read* total galls. of solution.] J. B. C. K.

636. *Water Purification by combined action of Permanganates and the Electric Current.* (D.R.-P. 166,625.)—In the process of E. Pellas and J. Legrand a soluble permanganate is added to the water to be treated [illegible]ly a current passed for a short time. The organic impurities are completely destroyed in from 2 to 5 min. if the current density is 0·05–1 amp./dm.² The oxidising action of the permanganate is accelerated by the electrolysis, which converts the salt into free alkali and permanganic acid. The latter, in the course of its oxidation of the impurities, is itself reduced to manganic hydroxide, which is insoluble and can be eliminated by filtration. L. H. W.

637. *24-ton Induction Furnace for Steel Manufacture.* (Electrochem. Ind., N.Y. 5. pp. 172–174, May, 1907.)—Illustrated description of 78[illegible]-kw. Kjellin furnace at the Roechling Iron and Steel Works, having a capacity of 24 tons of steel, of which 15 tons are poured away at a time. Reference is also made to a fourth induction furnace under construction, having a capacity of 150 tons. This is not intended for direct steel production, but will be used as a mixer and reservoir, keeping the metal to be used in the refining furnaces in a molten condition. Statistics are given of the various furnaces of this pattern installed or under construction. Also the relation between furnace capacity and power consumption is set out in the following figures:—

Capacity in kg. steel	50 to 60	800	955	15,[illegible]00
Electric power in kw.	50 to 78	110 to 120	150	7[illegible]6
Approximate ratio of kw. to kg.	1	1/8	1/6	1/[illegible]0

It is also pointed out that for small furnaces making tool steel in competition with crucibles electrical energy is only a single and comparatively small item.

W. P. D.

638. *Magnetic Separation of Iron Ores by the Gröndel Process.* **P. McN. Bennie.** (Electrochem. Ind., N.Y. 5. pp. 184–188, April, 1907. Abstract of paper read before the Canadian Mining Inst.)—A detailed and illustrated

description of the Gröndel process for concentrating and briquetting iron ores as worked at Herräng Ironworks in Sweden. [See Abstract No. 156 (1907) for main features of this process.] As regards costs the author gives the following additional information: *Cost of Plant.*—For a plant dealing with 400 to 500 tons of crude ore and producing 200 tons of concentrates per day the capital outlay is estimated at $45,000 for the concentrating portion of the plant and $65,000 for the briquetting plant—or $110,000. The figures quoted are based upon the cost of materials and cost of erection in the U.S.A. The working costs of the concentrating plant will vary with the character of the ore treated and with the amount of iron contained in the same. Assuming the treatment of an ordinary magnetic ore, containing 40 per cent. of iron, and the production from this of concentrates containing 68 per cent. of iron, the costs of the mechanical and magnetic process of concentrating will be from 30 to 45 cents. per ton of concentrates, the original cost of the ore not being included in this total. As regards the cost of the briquetting operation, a plant of 200 tons' capacity, consisting of four to seven furnaces, could be worked at cost of between 45 and 85 cents. per ton of briquettes. In a small plant of one furnace producing 25 to 30 tons of briquettes per day from pyrites residues the actual cost, including labour, coal, rent, and taxes, but excluding depreciation and royalty, amounts to 85 cents. per ton. On the other hand, at a typical plant in Sweden, turning out 120 tons of briquettes daily, the cost is 77 cents. per ton; while at a more recently constructed Swedish plant the cost has been reduced to 67 cents. per ton. Recently the briquetting furnace has been improved, the capital outlay upon the furnace and cost of working it being both reduced. The author concludes by urging the importance of the Gröndel process for Canada, which possesses large bodies of magnetic iron ores that could be made more saleable by concentration and briquetting. J. B. C. K.

639. *Utilisation of Waste India-rubber.* **W. F. Reid.** (Soc. Chem. Ind., Journ. 26. pp. 441–442; Discussion, pp. 442–443, May 15, 1907. Paper read before the Liverpool Section, April 10, 1907.)—The increased demand for rubber, due to electrical progress and improved methods of locomotion, renders the supply problem serious, especially as in motor tyres mechanical deterioration takes place long before chemical disintegration. Last year 68,000 tons of rubber were produced: 42,800 tons in America, 23,400 tons in Africa, and 1,800 tons in Asia and Polynesia, including some plantation rubber of excellent quality. Most rubber is originally of good quality; but light deteriorates it, this effect beginning on the trees, and vulcanised rubber is less durable than pure rubber. Vulcanised rubber which has turned brittle, owing probably to the action of the traces of sulphuric acid in the sulphur, is valueless. In the waste-utilisation processes the filling materials (minerals, carbonates and sulphates, clay, white lead, litharge) and the textile fabrics, of which there may be ten thicknesses in half an inch, have to be removed. The fibre can sometimes be removed from the coarsely-ground rubber by currents of air; in other cases sulphuric acid or alkalies have to be used for the destruction of the fibre, but this is detrimental to the rubber. Vulcanised rubber can be converted into a homogeneous mass by superheating, and at higher temperatures some of the solvents which fail to extract the sulphur in the cold will dissolve vulcanised rubber, but hardly without decomposition of the rubber. A. Tixier (French Pat. 370,619) has brought out a utilisation process which yields a viscid rubber; the recovered rubber will stand a large admixture of mineral materials, can be vulcanised, and

resists chemical reagents. The rubber, vulcanised or not, is reduced to a pulp, and digested with twice its weight of terpineol at 100 or 150° C.; the resulting solution is agitated with four times its volume of benzene, which precipitates some impurities; the clear liquid is decanted and the benzene distilled off, and the rubber precipitated by the addition of alcohol or acetone. In the *discussion*, **M. Muspratt** doubted that the Ceylon rubbers, although chemically as good apparently as Para, were equal to it in strength; the washed dried article was inferior to Para. A recovered rubber might be capable of further vulcanisation, as there were a large number of stages of vulcanisation, but in the washed, dried condition none had given satisfaction so far. H. B.

640. *Leakage Indicator for High-voltage Lines.* (Electrical World, 49. p. 988, May 11, 1907.)—Considering a three-phase transmission line connected to the secondaries of step-up transformers having a Y-connection with the neutral point earthed, it is evident that so long as the insulation of the line remains perfect the algebraical sum of the currents in the three wires will vanish at every instant. Hence, if a current transformer be connected in series with each line wire, and the secondaries of the current transformers be paralleled with each other and with an ammeter, the ammeter reading will remain zero so long as the insulation of the line is maintained. An earth on one of the wires will, however, cause the algebraical sum of the three line-currents to be different from zero, and the resultant current will flow through the ammeter, which will give a reading. The application of this principle to the construction of a leakage indicator has been patented by J. E. Woodbridge and J. B. Taylor (U.S. Pat. 851,149). A. H.

641. *Starting Current Ammeter.* (Elektrische Kraftbetr. u. Bahnen, 5. pp. 297–298, May 24, 1907.)—According to the rules of the *Verband*, the starting current of a motor should not exceed a definite limit depending on the output. It is evident, however, that since the initial value of the current lasts only a very short time, the first swing of an ammeter will not measure it correctly, as the amplitude of the swing depends on the amount of damping. In order to overcome this difficulty the firm of P. Meyer, of Berlin, supplies a form of ammeter provided with a movable arm, by means of which the pointer may be carried round to any desired part of the scale. When so blocked, the pointer will only move if the current exceeds the value corresponding to the blocked position. This position is varied by trial until the pointer is just seen to move at the instant of switching on. A. H.

642. *Dielectric Losses.* **B. Monasch.** (Elektrotechnik u. Maschinenbau, 25. pp. 815–822, April 21, and pp. 818–822 [incorrectly numbered], April 28, 1907. Extract from Dissertation, Danzig.—The author describes an investigation into the exact law connecting dielectric loss with field intensity. As a result, it is found that the loss varies (accurately and not approximately) as the square of the impressed voltage. The dielectric loss in cables at ordinary frequencies may be taken as proportional to the frequency. For particulars as to experimental method employed, see fuller account from the Annalen [Abstract No. 1084A (1907)]. L. H. W.

643. *Permissible Current-density in Conductors.* **J. Teichmüller** and **P. Humann.** (Elektrotechn. Zeitschr. 28. pp. 475–479, May 9, 1907. Écl. Électr. 51. pp. 817–819, June 1, and pp. 884–887, June 15, 1907.)—The authors have carried out a number of experiments on the heating of bare and insulated conductors, and find that for a temperature-rise of 10° C. the relation connecting the current i with the diam. d of the conductor may be represented by a formula of the type $i^2 = Ad^2 + Bd^3$, where A and B are constants for a given type of conductor. The same formula (with appropriate values of A and B) is found to hold good for both bare and insulated conductors; experiments with the latter have confirmed the known result that the insulating covering lowers the temperature-rise. The authors express the opinion that wiring tables should be drawn up so as to conform to the above formula. A. H.

644. *Fuses.* **G. J. Meyer.** (Elektrotechn. Zeitschr. 28. pp. 430–435, April 25, and pp. 460–464, May 2, 1907. Paper read before the Elektrotechn. Verein, March 26, 1907. Écl. Électr. 51. pp. 281–282, May 25; 314–317, June 1, and pp. 349–352, June 8, 1907.)—The author studies the law of temperature-rise in fuses when the current is maintained at a constant value exceeding that required to fuse the wire, and thus arrives at the time required to produce fusion with various currents. The steady temperature-rises corresponding to various currents less than the fusing current are next determined, and curves are plotted for various metals connecting the temperature-rise with the current expressed as a percentage of the fusing current. These curves are, in the case of metals having a high fusing-point, found to rise very rapidly in the neighbourhood of the fusing current, so that even with a current equal to 90 per cent. of the fusing current the temperature-rise is comparatively small. Thus it appears that in the case of copper there is little danger of oxidation and permanent alteration in the fuse even when this is worked fairly close to the fusing-point, and the author thinks that copper is quite equal to the more commonly employed silver. The difference in the behaviour of a given fuse when tested on a low-voltage circuit and on a high-voltage one is next considered. Photographs are reproduced of samples fused at low voltage and with a current only slightly in excess of the fusing current. As regards the use of aluminium fuses, the formation of a skin of oxide is no disadvantage, as in the case of thick wires the expansion of the molten metal is sufficient to rupture the skin of oxide. Motor circuits should be fused with materials having a considerable time-lag, while fuses on lighting circuits should act quickly. Silver and copper yield quick-acting fuses, while lead, tin, and zinc are slow-acting; of the last three, zinc is the slowest, and has the least mass, so that the amount of metal scattered when the fuse is blown is less than in the case of lead and tin. Considering the rating of fuses, the author recommends the adoption of a nominal current (corresponding to the normal current in the circuit to be protected) which will allow of a limiting overload of 50 per cent. in the case of a lighting circuit fuse, and an overload of 70 to 80 per cent. in the case of a motor fuse. A. H.

645. *Use of Nernst-Lamp Resistances in Automatic Motor-starters.* **M. Kallmann.** (Elektrotechn. Zeitschr. 28. pp. 495–497, May 9, and pp. 518–520; Discussion, pp. 520–521, May 16, 1907. Paper read before the Elektrotechn. Verein, Nov. 27, 1906.)—A new type of automatic motor-starting switch has been devised by the author, whose action depends on the rapid change of resistance with current in the case of iron wire or strip

enclosed in a glass bulb filled with hydrogen. The properties possessed by such resistances had previously been applied by the author to other purposes [Abstracts Nos. 298 and 572 (1906)]. At first sight, such resistances would appear totally unsuited to the purpose, since their resistance when cold is low, and increases with rise of current. It is found, however, in practice that the initial rush of current which takes place on first closing the switch is of very short duration, the iron wire spirals rapidly attaining a high temperature and limiting the current to the permissible value. In order to reduce the initial current rush, the first section of the starting resistance consists of an ordinary resistance of nickelin. The elements which compose the automatically varying resistance have capacities of from 1 to 6 amps. and 50 to 100 volts. The entire starting resistance consists of three sections, the first being the constant resistance and the remaining two automatically varying ones. An electromagnet, whose winding is connected across the armature of the motor, is provided with two contacts, which it closes in succession; the closing of the first contact short-circuiting the constant resistance and the first section of the variable resistance, and that of the second short-circuiting the whole of the starting resistance. The advantages claimed for the new type of starter are compactness and cheapness. A. H.

646. *Slipping Magnetic Clutch.* (Brit. Pat. 4,849A of 1907. Engineering, 83. p. 697, May 24, 1907. Abstract.)—H. W. Ravenshaw, V. G. Middleton, and W. E. Townsend have patented an arrangement whereby any desired amount of slip may be obtained with a magnetic clutch. This is effected by a periodic make and break of the exciting current, the relative duration of the make and break being arranged to be continuously variable. In one form of the device, a brush presses against a rotating contact-drum, which carries a sheet-metal cylinder, one of whose edges is deeply serrated. The brush in passing over the serrations periodically makes and breaks the circuit, and by a longitudinal displacement of the brush the period of "make" may be steadily increased, and the slip reduced, until finally the brush bears on the continuous portion of the metal surface. A. H.

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647. *Storage Batteries and their Electrolytes.* **R. W. Vicarey.** (Faraday Soc., Trans. 2. pp. 222–233; Discussion, pp. 233–236, Feb., 1907. Electrician, 58. pp. 411–412; Discussion, pp. 412–413, Dec. 28, 1906. Abstract.)—Reiterates the conclusions put forward in the paper dealt with in Abstract No. 47 (1906).

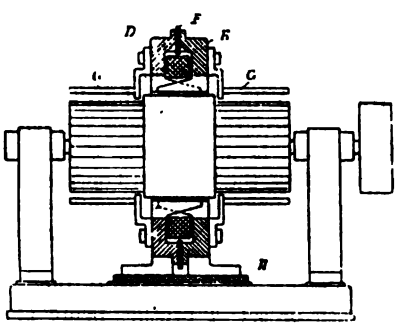
648. *Theory of Synchroscope.* **D. H. Cohen.** (Electrical World, 49. p. 887, May 4, 1907.)—The author explains in a simple manner the action of the synchroscope devised by P. M. Lincoln [Abstract No. 193 (1902)]. A. H.

649. *Harmonic Analysis of Alternating Current Wave-forms.* **H. Vavrečka.** (Elektrotechn. Zeitschr. 28. pp. 482–484, May 9, 1907.)—The graphical method described by the author is of limited application, being confined to waves which are symmetrical not only as regards their positive and negative halves, but also with respect to the ordinate half-way between two consecutive zero values. The method allows of the determination of the harmonics up to and including the ninth. The second part of the paper deals with the determination of the area of the wave.
A. H.

GENERATORS, MOTORS, AND TRANSFORMERS.

650. *Characteristic Curves of a Direct-current Machine.* **H. W. Smith.** (Technology Quarterly, 20. pp. 119–132, March, 1907.)—The magnetisation curve is first obtained by separately exciting the machine and taking simultaneous readings of the magnetising amperes and the voltmeter between the brushes, the speed of the machine being maintained constant. The magnetisation curve for any other speed can then be obtained by simply altering the scale. It is pointed out that the magnetisation curve, owing to the hysteresis of the iron, consists of an ascending and a descending branch. The shorter the air-gap the greater will be the distance between the two curves. It is next shown how to construct the external characteristic of a shunt generator, a simple graphical construction being given for the critical speed. When the armature reaction is negligible it is shown how the series turns required for compounding can be readily obtained from the magnetisation curve, and the effect of change of speed is also considered. Finally, simple and useful methods of discussing the effect of terminal e.m.f. on the speed of the motor and of drawing the speed curve for a series motor are given. The actual performance of the machine may differ appreciably from that given in the diagrams when the field is weak, owing to the relatively large effect of armature reaction. A. R.

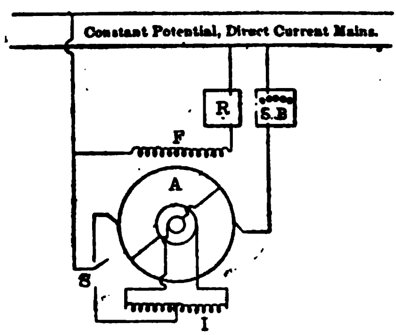
651. *New Design of Low-voltage Dynamo.* (Brit. Pat. 7,961 of 1906. Engineer, 103. p. 483, May 10, 1907. Abstract.)—The main advantage claimed for the design shown in the Fig. due to W. Siebert, is the simplicity of the brush gear. Two commutators are provided, all the brushes bearing



on one being positive and all those on the other negative. The field is provided with a single exciting coil; the field frame is cast in two halves which are insulated from each other, and which serve not only as field cores, but as brush carriers, collecting rings, and terminals. A. H.

652. *New Method of Speed Control for Continuous-current Motors.* **B. F. Bailey.** (Electrical World, 49. pp. 947–948, May 11, 1907.)—The author has devised a method for considerably extending the range of speed control of a shunt-wound motor which can be easily applied to any motor of ordinary construction. The motor armature must be fitted with one, two, or three slip-

rings which are connected through choking coils to one of the mains. For the sake of simplicity consider the case in which points in the armature winding 180 electrical degrees apart are connected to two slip-rings, as shown in the Fig. The slip-ring brushes are across the ends of a reactance coil (having a closed magnetic circuit), the middle point of which may be connected to one of the mains. When this connection is established the motor brush which is in connection with the same main is disconnected. Assuming the middle point of the reactance coil to be in connection with the positive main, the current entering at this point has two paths open to it—one being through one-half of the reactance coil, and the section of the armature winding between the point of connection of the first slip-ring and the negative brush, and the other through the remaining half of the coil and the section of the winding between the second slip-ring and the negative brush. The e.m.f.'s in the two sections of the winding will only be equal if the points of connection of the slip-rings are displaced 90 electrical degrees from the brush; in any other position the e.m.f. of one section is greater than that of



the other, and balance of the total e.m.f.'s in the two paths between the mains is maintained by the choking coil, the two halves of which act as the primary and secondary of a transformer. When the points of slip-ring connection coincide with the positions of the brushes, the transformer action is at its maximum, and the armature is supplied at a p.d. equal to twice that of the mains. The final result is the same as if the motor armature were supplied at double the voltage of the mains. The method of increasing the speed from its minimum to its maximum is as follows: A two-way switch is provided, in the first position of which the connections of the motor are those ordinarily used, the reactance coil being disconnected, and in the second position of which the choking coil is thrown into circuit, the corresponding motor brush or set of brushes being at the same time disconnected. The lowest speed is obtained with the switch in its first position, and all the field rheostat resistance cut out. By gradually weakening the field, the speed is increased to the limit permissible by considerations regarding sparking. The switch is next momentarily opened (the field remaining across the mains), the field resistance cut out, a safety or buffer resistance introduced into the armature circuit, the switch thrown into its second position, the buffer resistance cut out, and the speed further increased to the permissible limit by weakening the field. It is evident that by this method the permissible ordinary range of speed variation may be doubled. The method may also obviously be applied to series motors.

A. H.

653. *Magnetic Leakage as affecting Electrical Design.* **W. Cramp.** (Inst. Elect. Engin., Journ. 38. pp. 548–584; Discussion, pp. 584–589, June, 1907. Paper read before the Manchester Section. Elect. Engin. 39. pp. 46–53; Discussion, p. 53, Jan. 11, and pp. 82–87, Jan. 18, 1907. Elect. Rev., N.Y. 50. pp. 271–275, Feb. 16, and pp. 304–307, Feb. 23, 1907. Abstract. Écl. Électr. 50. pp. 384–386, March 16; 425–427, March 23, and pp. 451–453, March 30, 1907.)—In multipolar machines the leakage coefficient varies from 1·5 to 1·15 for outputs up to 200 kw.; beyond 200 kw. it steadily decreases until it reaches a value of about 1·1 at 1,000 kw. From this it is evident that no great saving in the cost of materials can be effected by the adoption of a special design having for its object the reduction of the leakage coefficient, so long as we are dealing with large machines. But in small machines (up to 20 h.p.) an appreciable improvement may be made, and the author describes a design in which a considerable reduction in the leakage coefficient (from 1·35 to 1·1) results in a smaller over-all diameter and a reduced cost per kw. In this design the pole cores are made tapering inwards, and are short and hollow; almost the entire space between them is taken up by the coils. The author next considers machines in which the flux is produced by a winding on the armature itself, and some experiments are described which were carried out on a machine whose armature had a double winding and two commutators, one winding being used as the field and the other as the armature winding. In the case of a series motor without field coils, the equivalent of a double winding on the armature may be obtained by displacing the brushes from the neutral point, and the ratio of armature to field ampere-turns may be easily altered by brush displacement. Such a motor would require a larger commutator and a smaller reactance voltage than the ordinary series motor, and it could only be of commercial value in special cases. Considering next leakage in alternators, the author shows how it may be usefully applied to render the alternator self-compounding; the principle employed, which consists in utilising the leakage flux to supply the field of the exciter, is identical with that recently described by Heyland [Abstracts Nos. 1806 (1906), 298 and 530 (1907)]; the author states that this principle had been utilised by himself as far back as 1904. As developed by the author, the method is specially applicable to alternators of the inductor type. After briefly referring to leakage in induction motors and the method of calculating the leakage factor, the author describes a type of motor devised by himself, which is arranged as follows: Imagine a two-pole series-wound motor short-circuited, and let a ⊓-shaped laminated core be applied to its poles, this core carrying a suitable exciting coil connected across the mains. The addition thus made to the motor converts it into a combination of a motor and transformer, and makes it especially suitable for high voltages. A. H.

654. *The Law of Magnetic Attraction.* **R. V. Picou.** (Soc. Int. Élect., Bull. 7. pp. 307–319, May, 1907.)—Very little has been written about the magnetic attractions between the parts of electromagnetic systems which are at appreciable distances apart. When they are very near, Maxwell's formula $B^2S/8\pi$ is always used. Let W denote the energy of a system linked with a flux Φ and having an excitation ni. Then, assuming that the system contains only soft iron, it is well-known that $W = -ni\Phi$. If now one of the parts of the system be moved through a distance dx, the increment of W will consist of two equal parts, the one being due to the mechanical work Fdx done, the other to the increase of the energy stored up in the field. Hence $Fdx = -(1/2)\,d(ni\Phi)$, and assuming that i is maintained constant, we have

$Fdx = -(1/2)\,ni\,d\Phi$. Now $\Phi = 4\pi niP$, where P is the reciprocal of the reluctance (the permeance), and hence—

$$F = 2\pi (ni)^2 \frac{dP}{dx} \quad \text{.............................(1)},$$

and this is the true law to give the attraction. Assuming that the breadth of the air-gap is x, the area of the cross-section of the path of Φ is S and that l is the mean length of this path, we have—

$$R = (l/\mu + x) \times 1/S.$$

Hence—

$$P = S/(l/\mu + x),$$

and—

$$dP/dx = -S/(l/\mu + x)^2 = -S(\mu^2/l^2),$$

if x be small compared with l/μ. Hence—

$$F = \frac{16\pi^2(ni)^2\mu^2 S}{8\pi l^2} = \frac{B^2 S}{8\pi}.$$

The author discusses various uses to which the formula (1) may be applied in electrotechnics. For instance, it may be applied to calculate the force acting on the armature of a multipolar machine when the shaft is not accurately centred. If we define the eccentricity ϵ as the ratio of a/e_0, where e_0 is the breadth of the normal air-gap and a is the distance between the axis of symmetry and the actual position of the axis of the shaft, we find by (1) that—

$$F = 2\pi(ni)^2 \frac{S}{e_0^2} \frac{\epsilon}{(1-\epsilon^2)^{3/2}} \quad \text{.........................(2)},$$

where S is the area of all the polar faces. A formula very similar to this was previously obtained by J. Rey by a different method. If we have a dynamo with a vertical shaft and if the median horizontal plane of the armature be at a distance a below the median horizontal plane of the field magnets, then the upward force F on the armature is given by—

$$F = 2\pi(ni)^2 pa/e_0 \quad \text{..............................(3)},$$

where a is the length of the polar arc of each pole. As an example of the use of these formulæ a 20-kw. 4-pole machine is considered. In this case $ni = 4{,}690$ amp.-turns $= 469$ c.g.s. units. $S = 2{,}340$ cm.^{2}, $e_0 = 0{\cdot}3$ cm., $a = 25{\cdot}6$ cm., and $a = 0{\cdot}03$ cm., so that $\epsilon = 0{\cdot}1$. We find by (2)—

$$F = 2\pi(469)^2[2{,}340/(0{\cdot}3)^2] \times 0{\cdot}101 = 360 \times 10^6 \text{ dynes} = 368 \text{ kg. weight nearly.}$$

As the distance between the bearings is 85 cm. and the diam. of the shaft is 7 cm. we easily find that its maximum displacement is 0·5 mm. per ton. Its deflection under a force of 368 kg. is therefore negligible compared with the breadth of the air-gap. But the pressure on the bearings due to the magnetic attraction will be at least double that due to the pull of the belt, to which it will in general be added. Let us now suppose that the armature is well centred, but displaced longitudinally; the opposing magnetic force takes immediately its maximum value which by (3) is given by—

$$F = 2\pi(469)^2 \times 2 \times 25{\cdot}6/0{\cdot}3 = 236 \times 10^6 \text{ dynes} = 240 \text{ kg. weight.}$$

This force is less than the weight (360 kg.) of the armature, so that in this case the attraction does not compensate for the weight completely. A. R.

655. *Methods of determining Leakage Coefficient.* **R. Pohl.** (Electrician, 59. pp. 215–216, May 24, 1907.)—Two methods are described by the author. In each, an exploring coil is placed on the armature, and another is wound round the field coil close to the yoke. A resistance box and sensitive galvanometer are required for carrying out the test. In the first method, the two exploring coils are joined in series with each other and with the known resistance, and the galvanometer is connected between the junction of the two coils and an intermediate point of the resistance. The two sections of the resistance are varied until the galvanometer gives no deflection when the exciting circuit is made or broken. The ratio of the two sections of the resistance gives the leakage coefficient. In the second method, the exploring coil on the field is connected across the resistance, while the exploring coil on the armature is joined in series with the galvanometer and then connected across a portion of the resistance, the connections being so arranged that the currents induced in the two coils tend to pass through the galvanometer in opposite directions. When balance is obtained, the ratio of the total resistance to that part of it which is shunted by the armature coil and galvanometer gives the leakage coefficient. A. H.

656. *Calculation of the Leakage Reactance of Induction Motors.* **I. E. Hanssen.** (Electrical World, 49. pp. 686–688, March 30, 1907.)—The author presents in a condensed form the several formulæ contained in C. A. Adams' papers [St. Louis Internat. Elect. Congress, Trans. Vol. 1. p. 706, 1904, and Abstracts Nos. 1120, 1546 (1905)] on this subject. The total leakage reactance is here obtained by the summation of the component leakage reactances, viz., slot, zigzag, end-connection and belt leakages. The author has added an expression for the "belt leakage" in the case of motors having squirrel-cage rotors, and he has also introduced a coefficient "k" termed the pitch coefficient. In the article two sets of curves are given, from which are obtained the values to be assigned to the variable coefficients contained in the formulæ. There is also given in the article a table of the necessary particulars of fifteen induction motors varying in size from ¼ to 75 h.p., together with their test and calculated values for the leakage reactance, and the greatest discrepancy between these two sets of values is shown to be 9 per cent. The final formula for the calculation of the total leakage reactances, together with the meaning of the symbols used, is, however, too lengthy for reproduction here. A. G. E.

657. *Circle Diagram of Induction Motor.* **G. Haberland.** (Elektrotechn. Zeitschr. 28. pp. 479–482, May 9, 1907. Écl. Électr. 51. pp. 382–384, June 15, 1907, *et seq.*.)—The author establishes the circle diagram by a method for which he claims the advantage of simplicity as compared with other methods hitherto published. In order to construct the diagram, the following determinations must be made: (1) the open-circuit rotor e.m.f. per phase when the stator is supplied at a known p.d., the stator current being measured; (2) the open-circuited stator phase p.d. when the rotor is supplied with a known current at a known phase p.d.; (3) the power absorbed by the motor when running light. The resistances of the windings are supposed to be known. Tests carried out with a 6·5-h.p. three-phase induction motor show satisfactory agreement between the experimental results and those deduced by the aid of the circle diagram. A. H.

658. *Single-phase Unipolar Motor.* (Electrical World, 49. pp. 986–987, May 18, 1907.)—A patent issued to C. Macmillan (U.S. Pat. 850,664) describes a

form of single-phase machine (unipolar) with no commutator but possessing series motor characteristics. The machine acts on the transformer principle, portions of the secondary circuit being formed by conductors on the rotor. Both the primary and secondary turns surround a common ring core mounted on the stator. The primary and secondary windings are so spaced that when current flows in them a large leakage flux passes perpendicularly through the rotor. The leakage flux which cuts the rotor current at right angles produces the torque. The armature conductors of the rotor consist of plates practically extending round the armature, but they are cut across in two or more places so as to prevent the flow of short-circuit currents. It is stated that the torque of the machine is proportional to the square of the impressed voltage.

A. R.

659. *Theory of the Single-phase Commutator Series Motor.* **J. Bethenod.** (Écl. Électr. 51. pp. 181–188, May 11, 1907.)—In a preceding paper [Abstract No. 1658 (1905)] the author discussed the method of designing motors so as to obtain a high power-factor at normal speed and a high starting torque. He now discusses the problem of designing an induction commutator motor, so as to obtain the minimum loss for a given starting torque. The losses are classified as follows: (*a*) The copper losses (H_1) in the exciting windings. For a given motor body they are proportional to the square of the exciting ampere-turns, that is, to the square of the exciting flux Φ, provided that the iron is not saturated, which is the usual case in practice. (*b*) The copper losses in the rotor and in the short-circuited compensating windings. The ratio of these windings being governed only by the dispersion, these losses are approximately proportional to the square of the rotoric ampere-turns A_r. (*c*) The losses in the iron due to hysteresis and eddy currents. These may be classed under two heads. (1) The losses F_1 due to the flux Φ. These are usually much the most important. As a rough approximation we may suppose these losses proportional to Φ_2. (2) The losses F_2 due to the leakage flux produced by the rotor and short-circuited windings. These losses are approximately proportional to the square of the leakage flux, and therefore to A_r^2. (*d*) The losses due to the passage of the line current I across the brushes and the commutator. For a given current these losses depend only on the rubbing surfaces and are independent of the constants of the windings. (*e*) The losses due to the short-circuit currents under the brushes caused by the flux Φ; they are jointly proportional to Φ_2 and to the square of the number of turns in the coil short-circuited. For a certain size of commutator, this number of turns is proportional to A_r. Hence these losses are proportional to $A_r^2\Phi^2$. They are therefore constant for a given torque G, since $G = kA_r\Phi$, where k is a constant. Hence the total losses at the start in an ordinary commutator series motor, for a given current and frequency are made up of constant losses (*d*) and (*e*), losses proportional to Φ^2 (H_1 and F_1) and losses proportional to A_r^2, (H_2 and F_2). It follows, by algebra, that for a given torque the total losses will be a minimum when the losses proportional to Φ^2 equal the losses due to A_r^2. Hence $H_1 + F_1 = H_2 + F_2$. If H denote the sum of the copper losses in the windings and F that of the losses in the iron, the above equation may be written $F - 2F_2 = H - 2H_1$ or $F(1 - 2F_2/F_1) = H(1 - 2H_1/H)$. It follows that the iron losses will be less than the copper losses if F_2/F_1 is less than H_1/H. This is usually the case in practice. The difference between H and F is never very large. For instance, when $F_2/F = 0{\cdot}1$ and $H_1/H = 0{\cdot}15$, we have $F = 0{\cdot}875H$. In what precedes we have supposed the line current I given and we have taken the flux Φ and the number of turns of the rotor

as the variables. If we suppose Φ and the rotoric current to be variable the losses (*d*) vary as the square of the current I and the losses (*e*) as the square of the flux Φ. It follows that if we denote these losses by P_1 and P_2 respectively, the condition for the minimum heating for a given couple becomes $H_1 + F_1 + P_1 = H_2 + F_2 + P_2$. But M. Latour has shown that in order to obtain the minimum heating of the commutator at the start P_1 must equal P_2. We thus obtain the same equation as before. We can always for a given current I taken from the network adjust momentarily the induced flux Φ and the rotoric current, so that their relative values will make $H_1 + F_1 = H_2 + F_2$. It is only necessary to make use of a Winter-Eichberg transformer or to shunt the excitation by an inductive coil. Similar reasoning applies to the series motor compensated by induction, the repulsion motor, and the Latour motor. It must be noticed, however, that in the latter case the functions of the stator and rotor are reversed. A. R.

660. *Starting of Induction Motors.* (Elektrotechnik u. Maschinenbau, 25. p. 358, May 5, 1907.)—The Siemens-Schuckert Works propose to start a polyphase induction motor without the use of any starting resistances, by the known principle of supplying the stator with currents of gradually increasing frequency. These currents are obtained from the rotor of an auxiliary induction motor whose stator is across the supply mains, and which is mechanically driven by another auxiliary motor. The main motor thus receives currents corresponding to the slip frequency. In order to increase the frequency, the second auxiliary motor is reversed, so as to act as an induction generator. By means of resistances, the speed of the auxiliary set may be varied at will until the main motor receives currents of frequency equal to that of the mains, when by throwing over a switch it is connected directly across the mains. [D. R.-P. 182,658.] A. H.

661. *Use of Polyphase Motors on Single-phase Mains.* (Elektrotechnik u. Maschinenbau, 25. p. 358, May 5, 1907.)—The following arrangement has been patented by the Siemens-Schuckert Works. Let *a*, *b*, and *c* denote the three phases of a star-connected stator winding; *a* is connected to one of the single-phase mains; *b* is in series with a non-inductive resistance, and *c* in series with a reactance coil. At starting, the *b* and *c* circuits are connected in parallel and to the other main. In order to obtain a low speed, the *c* phase is entirely disconnected; for a high speed, *b* is disconnected and *c* thrown into circuit. Lastly, phase *c* may be connected directly to the main, the reactance coil being cut out. [D.R.-P., 182,388.] A. H.

662. *Starting of Single-phase Induction Motors.* (Electrical World, 49. pp. 988–989, May 11, 1907.)—For the purpose of starting a three-phase induction motor which is to be operated from a single-phase supply, S. R. Bergman proposes the following arrangement (U.S. Pat. 850,205). Let 1, 2, 3 denote the stator terminals, and A, B the single-phase supply mains. Then 1 is connected directly to A; 2 is connected to B through a non-inductive resistance, and 3 is connected to B through a reactance coil and two-way switch, the connection through the latter being closed when the switch is in its starting position. When the switch is thrown into its second or running position, 3 is disconnected from B, and at the same time the non-inductive resistance between 2 and B is short-circuited, so that 1 and 2 are directly across the mains. The switch is operated *automatically* by an electromagnet connected

permanently across 1 and 3, the e.m.f. between 1 and 3 being at its minimum value at starting, and steadily increasing as the motor gains speed. J. B. Gury has patented a purely mechanical method of starting a single-phase induction motor. The switch blade is attached to the end of a rack engaging a pinion on the rotor shaft. On pushing down this rack in order to close the switch, the rotor is set in motion, and is thus already rotating when the switch is closed; the rack is held down clear of the pinion by a detent (U.S. Pat. 850,926). R. D. Mershon has patented the following starting device. Considering, for the sake of simplicity, a two-pole ring stator winding with the mains connected to diametrically opposite points, a reactance coil is connected to two diametrically opposite points displaced 45° relatively to the mains in one direction, and a condenser is connected to a pair of points displaced 45° relatively to the mains in the opposite direction. It is further claimed for this method that by using a condenser of suitable capacity, the power-factor under running conditions may be maintained at a high value. [U.S. Pat. 852,027.] A. H.

663. *New Methods of Suppressing Armature Reaction.* (Elektrotechnik u. Maschinenbau, 25. p. 187, March 3, 1907.)—The Siemens-Schuckert works have patented [Austrian Pat. 27,264] a form of series commutator motor in which the ring-shaped stator is provided with a single winding, whose magnetic axis is displaced by an angle lying between 0 and 90 electrical degrees from the axis of the brushes, the number of turns in this winding having a ratio to the number of turns on the armature, such that at all loads the resultant field is displaced 90 electrical degrees relatively to the brushes. In a machine patented by the Felten and Guilleaume-Lahmeyerwerke, each main pole is split, and each half provided with an independent field coil. The compensating winding is arranged on these poles in such a manner as to strengthen and weaken the main field on alternate (half) poles, and thereby counteract armature reaction. [D.R.-P. 179,280.] A. H.

664. *Method of Speed Control.* (Brit. Pat. 19,598 of 1906. Engineering, 83. p. 665, May 17, 1907. Abstract.)—The method described has been patented by Siemens Bros. The controlling rheostat of the main motor is geared, through a worm-wheel and worm, to a small controlling motor with independently excited field. The armature of this small motor is acted on by the difference between two opposing e.m.f.'s, one of which is that of a small motor-driven dynamo D_1, which runs at constant speed, while the other is provided by another small dynamo D_2 coupled to the main motor. Both D_1 and D_2 are independently excited, and control of the speed of the main motor is effected by means of a rheostat in the field circuit of D_1. A. H.

665. *Compensation for Speed Variation due to Heating of Field Coils.* (Brit. Pat. 14,438 of 1906. Engineering, 83. p. 665, May 17, 1907. Abstract.)—C. H. Iles and W. Armistead propose an arrangement having for its object the maintenance of constancy of field, and hence constancy of speed of a group of independent motors. The field windings of the motors are connected in series with each other, and are excited either from the supply mains or from an auxiliary source of e.m.f. By means of suitable arrangements the field current is maintained constant in spite of the temperature-rise in the field coils, the control of this current being effected either by hand, or automatically by either the field current itself or the armature speed. A. H.

666. *Balancers for Three-wire Systems.* **W. H. Taylor.** (Elect. Rev. 60. p. 751, May 10, 1907.—The usual arrangements adopted in connection with balancers lead to unsatisfactory results, balance not being properly maintained, and other troubles being experienced. The author finds that the following method gives the best results. Each balancer is provided with a compound winding, and the series winding of one is connected in series with the armature of the other, and *vice versâ;* the shunt windings are also cross-connected as usual. A small series resistance for fine adjustment is included in each armature circuit. The author states that balancers of this type are capable of regulating the p.d. on either side to 1 per cent. of their full-load capacity; their action is perfectly automatic, and they are not liable to race as are some other types. A. H.

667. *Oil* v. *Water Circulation fot cooling Oil-insulated Transformers.* **C. C. Chesney.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 473–474, April, 1907.) —On comparing the cost of the two systems, the author finds that while for small plants and small units the older method of water circulation is the cheaper, the newer method of oil circulation [Abstract No. 840 (1906)] is better for plants above 4,000 kw. when made up of units not less than 1,200 to 1,500 kw. A. H.

668. *Single-phase* v. *Three-phase Transformers.* **J. S. Peck.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 467–471, April, 1907.)—The author summarises the advantages of a three-phase over three single-phase transformers of the same total output as follows: (1) lower cost; (2) higher efficiency; (3) smaller floor space and weight; (4) simpler external wiring; (5) reduced cost of transport and installation. The disadvantages are (1) greater cost of *spare* units; (2) greater disturbance in case of a breakdown; (3) greater cost of repair; (4) reduced capacity obtainable in self-cooling units; (5) greater difficulties in bringing out taps for intermediate voltages. The disadvantages are thus chiefly such as only make themselves felt in the event of a breakdown —an occurrence which must be considered as abnormal and rare. Hence the results of the comparison are in favour of the three-phase transformer. The core type of construction is to be preferred to the shell type, as it is cheaper and is more easily repaired. The use of two single-phase transformers with a V or a T connection is not to be recommended, a serious objection to the arrangement being the fact that the three phases will not remain balanced as the load comes on. [See also Abstract No. 804 (1907).] A. H.

669. *Transformer Cooling.* **J. Pearson, F. R. Cutcheon.** (West. Electn. 40. pp. 394–395; Discussion, p. 395, May 4, 1907. Papers read before the Minnesota branch of the Amer. Inst. E.E., Feb. 8, 1907.)—J. Pearson dealt with air-cooled transformers, which, he said, were more liable to injury by static discharges than those cooled with oil, and were not self-restoring. He preferred the star connection for three-phase transformers on the high-tension side, with the centre earthed, and with a static by-pass across each coil. F. R. Cutcheon described experiences with oil-cooled transformers wound for 22,500 volts on the primary side, and 78 volts, or 2,100 to 2,600 volts, on the secondary side. It was found necessary to cool the oil with water circulation, and the water pipes condensed moisture from the air, which ran into the oil and caused a burn-out; this was remedied by lagging the pipes where exposed to the air. Much oil was lost by leakage and evaporation, and by

creeping up the stranded cables until they were soldered up solid. In the joint *discussion*, **J. C. Vincent** described troubles due to static sparking and strong induced currents between piles of laminations in air-cooled transformers. Other points were mentioned. A. H. A.

REFERENCES.

670. *Improved Form of Construction for Commutating Poles.* (Mech. Eng. 19. p. 653, May 11, 1907.)—The arrangement described has recently been patented by Mather and Platt, Ltd. The main yoke ring is not utilised as part of the magnetic circuit of the reversing poles. Two auxiliary yoke rings—one on each side of the armature—are provided for this purpose. These rings are connected by iron bars passing between the main poles, and the auxiliary pole is bolted to the middle portion of each bar, the two end portions being surrounded by the exciting coils. A. H.

671. *Commutation Problems.* **M. Walker.** (Elect. Journ. 4. pp. 276–289, May, 1907. Paper based on lecture delivered before the Engineers' Club, Manchester, England.)—The author deals with the general principles underlying the construction of brush-holders, the phenomena of commutation, brush contact drop, armature reaction, the use of a series winding and commutating poles for dealing with the sparking difficulty, and the common sources of trouble experienced with the commutator and brushes. A. H.

672. *Commutating Poles.* (Electrical World, 49. pp. 952–955, May 11, 1907.)—A brief general summary of the advantages and disadvantages of commutating-pole machines, with some illustrations of typical designs of this class of machine. A. H.

673. *True and Apparent Induction in Armature Teeth.* **J. K. Sumec.** (Elektrotechnik u. Maschinenbau, 25. p. 400, May 26, 1907.)—The author gives curves connecting these two quantities. The curves are based on the assumption that the flux passing into the slots is proportional to the fall of magnetic potential along the teeth. A. H.

674. *Automobile Motor.* (Elektrotechnik u. Maschinenbau, 25. p. 187, March 3, 1907.)—In a recent patent [French Pat. 350,261], A. Védrine and Co. describe a variable-speed motor, having a range of from 550 to 1,800 r.p.m., the speed control being effected entirely by the use of a shunt rheostat. Sparkless running is said to be secured by the use of very small and strongly saturated poles, and a special design of the yoke ring. [See also Abstract No. 364 (1906).] A. H.

675. *Induction Potential Regulators.* **W. T. Fernandez.** (Electrical World, 49. pp. 688–689, April 6, 1907.)—Describes the principle and arrangements of such regulators and gives hints as to erection and running.

676. *Capacity in the Secondary Circuit of a Transformer.* **P. Brenot.** (Écl. Électr. 50. pp. 404–406, March 23, 1907.)—A transformer having a condenser across its secondary terminals is called a "resonance transformer" and is used in wireless telegraphy, &c. The author gives a graphical method of studying this transformer when the magnetic leakage and hysteresis effects are negligible. A. R.

677. *Transformer Design.* **H. Bohle.** (Inst. Elect. Engin., Journ. 38. pp. 590–598, June, 1907. Paper read before the Cape Town Local Section.)—A collection of formulæ intended to facilitate transformer design [see Abstract No. 1569 (1905)]. A. H.

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ELECTRICAL DISTRIBUTION.

678. *Permissible Current Densities in Conductors.* **H. Passavant.** (Elektrotechn. Zeitschr. 28. pp. 499–500 and p. 514, May 16, 1907.)—In the new wiring rules of the Verband Deutscher Elektrotechniker, the permissible currents for various sizes of conductors have been worked out on the assumption that the temperature-rise does not exceed 20° C. The following table refers to conductors other than those laid underground :—

Cross-section, sq. mm.	0·75	1·0	1·5	2·5	4	6	10	16	25	35	50	70	95	120	150	185	240	310	500	625	800	1,000
Current, amps.	6	6	10	15	20	25	35	60	80	100	125	160	190	225	260	300	360	430	600	700	850	1,000

A. H.

679. *Permissible Currents in Underground Conductors.* **J. Teichmüller.** (Elektrotechn. Zeitschr. 28. pp. 500–502 and 515–518, May 16, 1907.)—The new rules of the Verband, relating to underground conductors, are based on the assumption of a maximum temperature-rise of 25° C. The following table refers to lead-sheathed cables for voltages up to 700 :—

Cross-section, sq. mm.	1	2·5	6	10	16	25	35	50	70	120	185	310	400	625	1,000
Current, amperes	24	41	70	95	130	170	210	260	320	450	575	785	910	1,190	1,585

Other tables refer to concentric, triple concentric, two-core and three-core cables for various voltages. A. H.

680. *Single-phase Power Transmission.* **O. Colard.** (Assoc. Ing. Él. Liége, Bull. 6. pp. 409–481, Nov.–Dec., 1906.)—A complete mathematical solution of the problem of the steady working of a single-phase power transmission line when the leakage currents are negligible is given. The solution also applies to the case of telephonic transmission when the line is well insulated, as for example in the case of underground or submarine cables. The mathematical discussion is very thorough, no difficulties being passed over. The solutions, being given in ordinary algebraical formulæ, can be used at once. They are necessarily long although hyperbolic functions are employed, but the author, by considering particular cases, makes his formulæ very intelligible. He finds expressions for the total e.m.f. of the generator, and for the apparent combined resistance of the line, generator and motor, or receiver. A. R.

681. *Power Transmission by High-voltage Direct Current.* **J. S. Highfield.** (Inst. Elect. Engin., Journ. 38. pp. 471–502 ; Discussion and Communications, pp. 502–545, June, 1907. Abstracts in Electrician, 58. pp. 794–796, March 8 ; 844–848, March 15 ; Discussion, pp. 890–892, March 22, 1907. Elect. Engineering, 1. pp. 471–477 ; Discussion, pp. 477–479, March 14, and pp. 505–509, March 21, 1907.)—The author describes the Thury system for the transmission of power by direct current on the series system, and discusses its relative advantages as compared with polyphase systems. He first points out that there is no special difficulty in making a single-core cable to work with direct current

at 60 kilovolts pressure to earth, and so with two such cables an effective working pressure of 120 kilovolts can be obtained. This cable can be more easily built to work with 20 kilovolts than a 3-core cable. The Thury system can be worked either as an ordinary 2-wire system with both poles insulated, as a 2-wire system using earth as the return, or as a 3-wire system using the earth as a middle wire. The earthing connection can be conveniently made at the bottom of a well in a good conducting stratum, so as to get clear of any surface metal work [see Abstract No. 409 (1907)]. Illustrated descriptions are then given of the power station, the line, and the substation on the constant-current series system. A full discussion is given of the capital and working costs of various systems, a typical bulk supply area being assumed. In conclusion the author indicates some of the advantages of the direct-current system, in particular the possibility of transmitting power to distances much greater than when polyphase currents are used. In the *discussion*, **Kelvin** said that he had never swerved from the opinion that the right system for long-distance transmission of power by electricity is the direct-current system. The practical working of a long-distance transmission line by direct current is much easier than by alternating current, and the dielectric strengths of the direct-current cables are much higher. The penetrating skill and perseverance of Thury having led the way, it is possible that the advantages of the direct current will prove sufficient to make it supersede the alternating-current system. **G. Kapp** gives data as to the costs of the two systems, and concludes that even on moderately long lines, when you have to use cables, the difference in the total cost is considerably in favour of direct current. **C. P. Sparks** points out that direct-current underground cables often cause difficulty owing to electrolytic troubles. When this is taken into account, the author's conclusions need to be modified. **T. Hesketh** points out some of the difficulties which arise in the working of high-pressure, direct-current, underground cables. He says that there is absolutely no difficulty in commutating 3 kilovolts. **W. H. Patchell** mentions that making an earth down a well is not a certain method of making the leakage currents near the surface negligible. **F. Bailey** states that for several years he has been running many miles of paper-insulated cable with 3 kilovolts direct pressure without any evidence of electrolytic or other trouble. **J. J. Fasola** gives particulars of the Albula-Zurich scheme. **H. M. Hobart** criticises the author's calculations. He states that he favours the *constant-potential*, high-tension, direct-current system for traction, simply because there is no good single-phase, alternating-current motor on the market. The 3-phase system, however, is so admirable for generating purposes, that he cannot see any useful purpose that could be served by replacing it by another system which was no cheaper. **J. T. Irwin** states that W. E. Ayrton favoured direct current when a purely overhead system was used, but he did not advocate it when any part of the mains had to be underground. **R. A. Dawbarn** considers that the system is best adapted for serving from one station four or five comparatively small industrial centres. **J. S. Peck** points out that the large number of small units, and the difficulty of insulating the generators and motors from earth, were serious drawbacks to the Thury system. **L. Andrews** states that in low-pressure, direct-current systems the osmotic troubles are serious. He criticises the devices used for short-circuiting the generators and the automatic slipping couplings, &c., comparing them unfavourably with the simple automatic devices used in parallel systems. **A. Russell** says that the electric stresses on the dielectrics of cables are, as a rule, quite different

with alternating and direct pressures. **G. Semenza** gives a list of the advantages and disadvantages of direct current for long-distance transmission. **A. W. Heaviside** points out that such a thing as a steady current from a mechanically driven plant does not exist, as there is always a ripple caused by the commutator slipping under the brushes. He gives records obtained by an undulator, showing that appreciable disturbances are caused in telephone and telegraph services by electric tramways, &c. **M. J. E. Tilney** points out the danger that may arise from confusing sparking with arcing distance. In his reply the **Author** admits that the earthing of the direct-current system presents difficulty, and personally he prefers to work with a completely insulated system. A. R.

682. *Regulation of Single-phase Networks.* (Elektrotechnik u. Maschinenbau, 25. p. 358, May 5, 1907.)—In order that the load fluctuations occurring in one branch of a supply network may not interfere with the voltage regulation of a parallel branch supplying a fairly constant load, the A.E.G. has devised the following arrangement: The primary and secondary windings of a series transformer are included in one of the mains of each circuit, these mains being connected to the same terminal of the generator, and the connections being so arranged that the currents flowing through the windings oppose each other in their magnetic effects [D.R.-P. 168,088]. A. H.

683. *Measurement of Insulation Resistance and Capacity of Alternate-current Mains during Working.* **J. Sahulka.** (Elektrotechn. Zeitschr. 28. pp. 457–459, May 2, and pp. 484–488, May 9, 1907. From the Elektrotechn. Inst. d. techn. Hochschule, Wien.)—Since the dielectric hysteresis loss is proportional to the square of the voltage, its effect may be imitated by that of a constant resistance placed across the terminals of a condenser having no dielectric hysteresis loss. The dielectric loss which occurs by reason of the capacity between mains may thus be regarded as a constant additional load on the mains; and the loss due to capacity between each main and earth may be supposed equivalent to the loss in a certain resistance connected between each main and earth. This resistance will be connected in parallel with the true insulation resistance (as measured by continuous currents) of the main, and the joint resistance of the two may be spoken of as the *earth loss resistance* of the main. The author describes a variety of methods for determining the earth loss resistances and the capacities to earth of the individual mains of an alternate-current system during working. The formulæ required in the various cases are deduced from a vector diagram. This latter is easily constructed by supposing that the actual mains are replaced by ideal mains having no capacity and perfect insulation, and that a condenser shunted by a resistance is connected between each main and earth. The condition that the algebraical sum of the instantaneous currents flowing from the mains to earth should vanish, fixes the relative positions of the earth current vectors in the vector diagram. All the methods described by the author depend on measuring, by means of an electrostatic voltmeter, the potentials to earth of the various mains, first under normal conditions and then when a known resistance is connected between a main and earth. The p.d.'s between the mains having been also measured, sufficient data are available for solving the equations which connect the known quantities with the capacities and earth loss resistances of the various mains. Numerical examples are given showing the application of the methods described to two- and three-wire networks. A. H.

684. *Verification of Dips and Tensions of Electric Wires.* **A. Pillonel.** (Schweiz. Elektrot. Zeit. 4. pp. 193–194, April 27, 1907.)—On uneven ground and in mountainous country it is difficult, after wires have been erected, to ascertain by the ordinary means that the proper dip has been allowed by the construction parties. The author has obtained accuracy by counting the vibrations made by the wire when it is caused to swing.

$$n = \frac{1}{rl}\sqrt{\frac{gP}{\pi d}}$$

Here n is the number of simple vibrations per sec.; r the radius of the wire; l the length between the points of support; P the tensile weight = the tension T; d the specific weight of the metal. From the above equation, and knowing that $T = pl^2/8f$, p being the weight of unit length of the wire, and further that $f = g/8n^2$ (g is constant for any one place), and thus—

$$f = 9{\cdot}81/8n^2 = 1{\cdot}226/n^2.$$

Thus the dip of a wire stretched between two supports is equal to 1·226 divided by the square of the simple vibrations per sec. The formula is useful because the length of the span, the diam. of the wire, and the inclination of the line are disregarded. The table gives the dip corresponding to each

Number of Double Vibrations in 30 Sec.	Corresponding Dip of the Wire in Metres.	Number of Double Vibrations in 30 Sec.	Corresponding Dip of the Wire in Metres.
10	2·758	26	0·408
11	2·279	27	0·378
12	1·915	28	0·351
13	1·632	29	0·328
14	1·407	30	0·306
15	1·22	31	0·288
16	1·077	32	0·269
17	0·954	33	0·253
18	0·851	34	0·240
19	0·764	35	0·224
20	0·689	36	0·212
21	0·625	37	0·206
22	0·570	38	0·188
23	0·521	39	0·181
24	0·478	40	0·172
25	0·441	—	—

number of vibrations between 10 and 40 double vibrations in 30 sec. The wire is swung by oscillating the support, or by other means. E. O. W.

685. *Electrostatic Stresses on Transmission Lines as affected by Earth Wires.* **R. P. Jackson.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 485–494, April, 1907.)—This paper contains a theoretical investigation of the potential gradients and equipotential surfaces around earthed overhead conductors run above transmission lines, and around metallic towers supporting such lines. The general practical conclusions arrived at are as follows: Properly placed and frequently earthed wires erected above a transmission line should materially reduce the electrostatic stresses on the insulators. An insulator mounted at the top of a tower, and having no earth wire above it to act as a shield, is exceptionally liable to break down. A. H.

686. *Multi-gap Lightning Arresters with Ground Shields.* **R. B. Ingram.** (Elect. Journ. 4. pp. 215–221, April, 1907.)—Multi-gap lightning arresters of similar design are known to have a varying discharge-point, apparently due to local conditions. Adjustable series gaps on the line side of the multi-gaps have not overcome the difficulty. A further trouble is the diminution in voltage-sustaining power of the respective gaps as the number is increased,

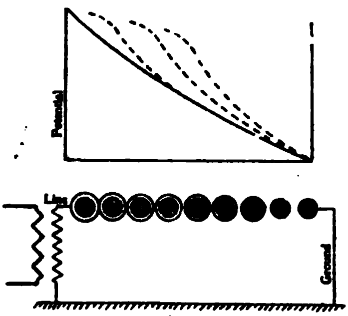


FIG. 1.

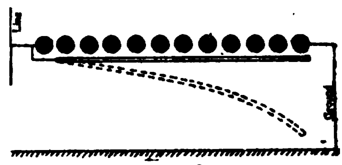


FIG. 2.

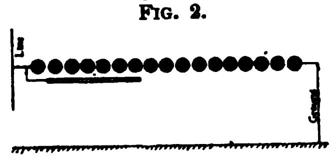


FIG. 3.

for higher voltages. The gaps act like condensers in series, each taking a potential in an inverse proportion to its capacity. Reduction in sustaining power is attributed to "ground potential influence," the intensity of which varies with the method of connecting the gaps in circuit and the distances to the ground. When an insulated conductor is charged to approximately 20,000 volts p.d. between an adjacent conductor, atomic structural rupture of the surrounding air will occur, and conduction of current result. The author employs Ryan's formula for this calculation [Abstract No. 1851 (1904)]. This air rupture may be produced in the gaps of a lightning arrester when

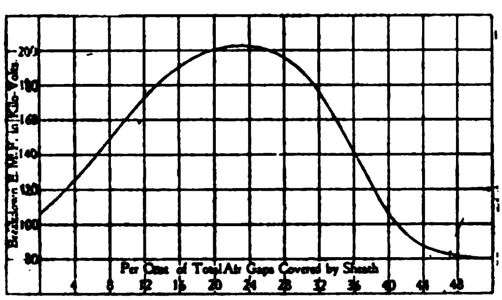


FIG. 4.

subjected to differences of potential. In Fig. 1 this effect is shown diagrammatically on a series of grounded gaps. The air round the first few cylinders becomes ionised, enclosing them with a partially conducting gas. The light circles in the diagram show that this envelope of gas may easily bridge the gap. The potential against ground accordingly shifts its position, as indicated by the dotted curves, travelling down the gaps until the last reach their breakdown voltage. This effect is noticeable to the eye. If the excessive p.d. between the gaps on the line side can be reduced, the sustaining power of all the gaps can be raised to their full value. The use of a ground shield enables this to be done. Fig. 2 illustrates a method of

applying such a shield, the strain against ground being transferred from the cylinders to the shield. A superimposed p.d. upon the gaps is occasioned by the shield, when shaped as in Fig. 2; the dotted line in the same illustration shows the ideal shape and position for the shield, but this is not practicable. A compromise must be resorted to and the length of the shield reduced as shown in Fig. 3, and placed closer to the gaps. The curve in Fig. 4 is from tests with gaps covered by varying lengths of shield. For any given number of gaps there is a suitable shield length to give a maximum break-down potential. For ungrounded conditions shields must be placed at both ends of the series of gaps, though this is seldom met with in practice. The use of ground shields with multi-gap arresters enables the exact break-down potential for a given voltage to be determined before installation, thereby avoiding calibration *in situ*. W. E. W.

687. *Protection against Lightning and New Form of Multi-gap Arrester.* **D. B. Rushmore** and **D. Dubois.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 847–881, April, 1907. Elect. Rev., N.Y. 50. pp. 638–648, April 20, 1907. Abstract.)—In the introductory part of the paper, a number of photographs of lightning are given. From the point of view of protection, the best arrangement of transformer connections is the star connection with the neutral point earthed. The horn arrester is not to be generally recommended: if used without any series resistance it has the effect of a short-circuit, while if a sufficient resistance is used the apparatus to a large extent loses its protective features. Horn arresters should only be used to protect insulators along a transmission line, the horns (which are used singly) being so arranged that a discharge will pass to the horn in preference to arcing around the insulator. The water-jet type of arrester is condemned by the author as incapable of affording any real protection to the line; it can only deal with very slow rises in potential. An earth wire run above the highest line wire affords good though not entirely complete protection against the effects of lightning. Such a wire should consist of a ⅜-in. stranded steel cable, earthed at least every 500 ft. In some cases the earth wire is carried on insulators and is identical with the line wires, so that it may be used as a spare conductor after disconnecting the earthing wires. As regards choking coils, these should have only a moderate amount of reactance, as otherwise an arcing earth on one of the line wires in series with a large reactance may give rise to resonance if the capacity of the line is considerable. Choking coils should have very little capacity between turns, and should consist of bare wire having no insulating covering. The multi-gap lightning arrester is next considered in detail by the author. If the behaviour of a multi-gap alone be compared with that of a multi-gap in series with a resistance, it is found that for a given voltage disturbances of high frequency prefer the multi-gap alone, while those of low frequency prefer the multi-gap with a series resistance. This has led the author to devise a new form of multi-gap arrester, which consists of a series of gaps and three resistances: a low resistance shunting the first few gaps at the line end, a second, higher resistance connected across a larger number of gaps, and a third, still higher resistance shunting a still larger number of gaps (one end of each resistance is connected to line). In this way disturbances of varying frequencies may be dealt with. This form of arrester is connected to the line wire through a fuse shunted by a spark-gap—a device intended to protect the arrester against a continuous high voltage on the line, such as might be brought about by an arcing earth. The fuse is so

proportioned that it will not blow with an ordinary discharge of momentary duration, and by its use the arrester may safely be arranged to discharge at a voltage but slightly in excess of the normal line voltage. A. H.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

688. *Fort Wayne and Springfield Single-phase Railway.* (Street Rly. Journ. 29. pp. 786–787, April 27, 1907.)—This is the third single-phase railway to be completed in Indiana. The first section of 21·6 miles, between Fort Wayne and Decatur, is now in operation. An interesting feature is the extreme simplicity of the arrangements. Power is generated in Decatur by two units, each consisting of a Buckeye cross-compound condensing engine direct-coupled to a 400-kw. single-phase, 6,600 volt, 25-cycle Westinghouse generator. No step-up transformers are employed, and only two circuits leave the power-house. One of these is a single line connected directly to the 6,600-volt trolley wire, while the other supplies a step-down transformer which feeds a 500-volt trolley line through Decatur. The rails weigh 70 lbs. per yard, and are in 30-ft. lengths; they are bonded with Ohio Brass Co. No. 0000 bonds. Wooden poles varying from 60 to 30 ft. are employed, the standard height being 30 ft., and their standard distance apart 120 ft.; on curves, they are 60 ft. apart. T-iron brackets 10 ft. long support triple-petticoat Locke No. 3 insulators which carry the messenger cable; from this the No. 0000 trolley wire is hung by hangers spaced 10 ft. apart, the length of the hangers varying from 7 in. at the middle of the span to 18 in. near the brackets. The line is protected by lightning-arresters, there being one to each $\frac{1}{4}$ mile of line. The passenger cars are 58 ft. long and 8 ft. 4 in. wide. Each car is equipped with 4 Westinghouse 75-h.p. 106-A type motors, the Westinghouse electro-pneumatic system of control being used. The trucks are of the Baldwin type with a 6 ft. 10 in. wheel base, steel-tyred wheels 34 in. in diam., with 3-in. treads and $\frac{7}{8}$-in flanges.
A. H.

689. *Effects of Acceleration on Winding Torques, and Test of the Tarbrax Electrical Winding Plant.* G. **Ness.** (Elect. Engineering, 1. pp. 332–338, Feb. 21, 1907. Paper read before the Mining Inst. of Scotland, Dec. 18, 1906.)—The Tarbrax plant was one of the first electrical winding-plants on the Ilgner flywheel system to be installed in the United Kingdom, and is not of such a large size as the majority of winding engines in coal-mines. The pit is 140 yards deep, and the net load for which the equipment is designed is 25 cwt. per wind. The whole cycle of operations is completed in just under 1 min., of which 30 sec. is allowed for decking. The maximum speed of the rope is 28 ft. per sec., and the acceleration reaches 23 ft. per sec. per sec. The drums run at 90 r.p.m. and are coupled directly to the single winding motor. The rated capacity of the 3-phase induction motor for driving the flywheel set is 80 b.h.p., but the continuous-current generator which it drives is capable of giving out about four times this output without sparking. The flywheel weighs 6 tons, and runs at speeds varying from about 650 to 785 r.p.m. Speed control is effected in the usual way by variation of the excitation of the flywheel generator, and a special arrangement is adopted for automatically inserting resistance into the rotor circuit of the induction motor for keeping the input constant with varying flywheel speeds. The installation has been fully described by J. Caldwell [Inst. Mining Engin.,

Trans. 31. p. 221; see also Abstract No. 1094 (1906)]. In July, 1906, a series of tests was made on this plant with a view to ascertaining the efficiency under working conditions. Each wind consisted in raising about 12¼ cwt. of shale from a depth of 420 ft. Under these conditions the winding plant was operated at about half the normal designed output. The results show that throughout the test the average power consumption was 0·54 unit per wind; and, allowing 12¼ cwt. for each wind, this shows a power-consumption of 0·87 unit per ton of shale raised during the test. The power taken to run the flywheel motor-generator from the 3-phase mains varied from 15 to 45 kw. This shows greater unsteadiness than was anticipated, but it is explained by the automatic slip resistance having been designed for the absorption of a greater maximum power, in the raising of two hutches from the mine, instead of one as at present. Owing to the load being small, the power-factor is also adversely affected, varying from 0·67 to 0·84, and having an average of about 0·7. The low power-factor necessarily lowers the efficiency of the plant, but with a power-factor of 0·9 the efficiency would be relatively high. The report states that the winder ran smoothly and very quietly, that the manipulation was simple and easy, and that the flywheel motor-generator produced no undue vibration at any alteration of velocity. The commutation is stated to have been sparkless during the whole course of the trial. As regards the commercial results, no figures are available. The following table contains an estimate of the cost of an installation of similar power which will serve as a guide, and can be used as a basis for the consideration of each individual case. This estimate includes the cost of 3,000 ft. of cabling, all the necessary spare parts, and also a stand-by set.

Estimated Cost of an Electrical Winding Plant.

Generators (including stand-by set), switchboard, buildings, boilers, brickwork, chimney, and cabling	£8,500	
One-third of this amount is charged against the winding-plant	£2,833	
Winding-plant, foundations, and building	£2,800	
Total capital charges	£5,633	
Depreciation and interest on capital, £5,633, at 10 per cent. per annum	£563	
Ditto, per week of 11 shifts of 8 hours each	£10 16s. 6½d.	
Ditto, per shift of 8 hours	£0 19s. 8·2d.	
Ditto, taking rated output of 640 tons in 8 hours, per ton		0·368d.
Oil and waste, including power station charges, per week	£0 15s. 0d.	
Wages of winders	£3 0s. 0d.	
Proportion of power-station wages chargeable against winding, per week	£1 0s. 0d.	
Total.........	£4 15s. 0d.	
Total, per ton.........		0·260d.
Coal, 4 lbs. per unit, at 6s. 8d. per ton.........		0·140d.
Total cost per ton of shale raised		0·768d.

H. M. H.

690. *Rathenow Electricity Works.* **H. Wille.** (Elektrische Kraftbetr. u. Bahnen, 5. pp. 81–87, Feb. 14, 1907.)—This small station is operated by gas

engines supplied from producers which can supply either pressure or suction gas. Two 200-h.p. Körting producers with engines and complete equipment are installed. The 3-wire, 440-volt system of distribution, with battery, is employed. The engines in the delivery tests required only 0·864 kg. of anthracite per b.h.p.-hour, at 184·7 h.p., or 0·41 kg. based upon a calorific value of 8,000 kg.-cals. L. H. W

691. *Single-phase Traction on the New York, New Haven, and Hartford Line.* **W. S. Murray.** (Street Rly. Journ. 29. pp. 546–548, March 30, 1907. Paper read before the Elect. Engin. Soc. of Columbia University, March 6, 1907.)—The working conductor consists of a No. 4/0 wire supported by a Δ catenary structure. The feeders are of No. 2/0 wire. The catenary is formed by two $\frac{9}{16}$-in. steel cables. The overhead system is supported at intervals of 300 ft. by means of bridges made of steel lattice-work. At intervals of 2 miles the overhead bridge is of special construction, being used both to anchor the line work and to contain the switches for disconnecting the trolley circuits or interconnecting them with feeders. The voltage employed is 11,000, and the frequency 25. There are no step-up or step-down transformer substations. The locomotive is equipped with 62-in. drivers, and the motor armatures are elastically mounted on the locomotive axles. The motors are 12-pole, and are provided with a compensating winding and resistance connectors between the armature and commutator; forced ventilation is used. A. H.

692. *Triple Motor-generator Set.* (Elektrische Kraftbetr. u. Bahnen, 5. p. 198, April 4, 1907. Elect. Rev. 60. p. 728, May 3, 1907.)—The power station of the Blankenese-Ohlsdorf line [Abstract No. 112 (1906)] in Hamburg contains generating plant for single-phase currents of frequency 25 to supply the railway motors, of frequency 50 to deal with the lighting load, and continuous-current plant for supplying the exciting currents and driving some auxiliary motors. In order to secure economical working, the three systems are linked together by means of two triple motor-generator sets, each set consisting of a 25-cycle and a 50-cycle single-phase alternator and a continuous-current machine, all mechanically coupled. Owing to the interchange of power which may thereby take place among the three systems, each section of the generating plant may be kept running fully loaded, the peaks of the load being taken by a secondary battery. A. H.

693. *Track Construction and Asphalt Work in Kansas City.* (Street Rly. Journ. 29. pp. 188–189, Feb. 2, 1907.)—This article deals with the chief features in the work of reconstruction in Kansas City. The rails chiefly used are T-rail standards, A.S.C.E. section, and weighing 80 lbs. and 100 lbs. per yard. Trilby rails are employed in the city districts. The ties rest on rock ballast. A specially formed brick, with a nose fitting in under the rail, is used on the gauge side of the rail. The latter is filled on the outside with a grouting, and against this an ordinary vitrified paving brick is placed. The company does its own asphalt resurfacing. The old asphalt is brought from the city, reheated, strengthened with new asphalt, and relaid. Illustrations are given showing the method in which this is done. C. E. A.

694. *New Electrically-driven Sewage Pumping Plant at Salem, Mass.* (Eng. Record, 55. pp. 215–216, Feb. 23, 1907.)—A number of unique features

characterise the system. The outfall is probably the longest on the Atlantic coast. The use of reinforced concrete in the sewer construction was attended with marked economy of cost, and the pumping station itself is completely electrical in its operating features. Three motive powers for driving the pumps were considered. In comparing these methods it was found that the first cost of the gas-engine station was about twice that of the electric drive, while the steam plant was about three times as expensive; the floor space required by the gas-engine station was about three times as great, and by the steam engine about five times as great as that needed by the electrical equipment. The central station company, the Salem Electric Lighting Co., felt justified in making the extremely low rate of 1¼ cents per h.p.-hour, on account of the desirability of the business; since it was stipulated that no power should be taken at the time of the peak load on the electric light plant, and that the max. demand for power, for flushing the sewer, was to be made only at the time of the valley load. W. J. C.

695. *Mule Haulage and Electric Haulage for Mines.* **M. F. Peltier.** (Eng. News, 57. pp. 271–272, March 7, 1907. Abstract of paper read at Convention of the Illinois Soc. of Engin. and Surveyors, Peoria, Ill., Jan. 23 and 25, 1907.)—The introduction of the electric haulage system in the mine of the Peabody Coal Co. has not only resulted in reducing the cost of production, but has also made practical the development of more extended operations, and increased the output from 1,400 tons to a daily average of 2,000 tons. Two 15-ton Goodman electric locomotives with double-end controller were installed. The wheels have steel tyres, which, it is claimed, gives them a tractive effort of 20 per cent. above chilled-rib wheels. Each locomotive is provided with two motors wound for 250 volts, and exerts a draw-bar pull of 8,200 lbs. on the level. The generator for the supply of power has 175 kw. capacity, and is belted to a 200-b.h.p. engine. Tables are given showing plainly that the plant is easily paying for itself in four years. W. J. C.

696. *Electric Haulage in Mines.* (Engineer, 103. p. 285, March 22, 1907.) —In the tunnels of two mining companies in Colorado electric haulage is in operation. At the Yak Mine zinc ore is handled. The power plant comprises a steam-driven air-compressor, a compressor geared to a 150-h.p. motor, a 475-kw. 3-phase alternator driven at 100 r.p.m. by a Corliss cross-compound engine, and a 75-kw. generator directly connected to a steam engine and driven at 275 r.p.m. This last supplies continuous current at 250 volts for lighting the entire outside plant. The 3-phase current is generated and transmitted at 6,600 volts, and is transformed at various substations to 440 volts for driving induction motors. In the tunnels there are three locomotives, each weighing 5 tons. The tunnel lines are 18-in. gauge and laid with 30-lb. flange rails on sleepers 32 in. between centres. Steel cars are used with rectangular side-tipping bodies. W. J. C.

697. *The Huronian Company's Power Development.* **R. A. Ross** and **H. Holgate.** (Canad. Elect. News, 17. pp. 129–139, May, 1907. Paper read before the Canad. Soc. Civil Engin., Montreal, April 25, 1907.)—Water is obtained from High Falls, on the Spanish River, in the township of Hyman. The main turbine wheels are designed for a maximum of 3,550 h.p. each. Each turbine operates a 2,000-kw. generator, so that the wheels have a capacity sufficient for operating the generators at 33 per cent. overload. The

effective head is 85 ft. and the speed is 375 r.p.m. The full load capacity of the station is 8,000 kw. The generators are each of 2,000 kw. capacity at 80 per cent. power-factor, 3-phase, 25 cycles, operating at 2,400 volts. The exciters, two in number, are directly connected to their own wheels. The transmission line from High Falls to Copper Cliff, operating at 35,000 volts, is about 29 miles long. The line consists of two 3-phase circuits. W. J. C.

698. *A Modern Ship-lighting Installation.* (Elect. Rev. 60. p. 824, May 17, 1907.)—The ss. *Rohilla,* of the British India Steam Navigation Co. carries two Paul-Holmes steam dynamos, each 100 b.h.p., 450 r.p.m., 100 volts, 685 amps., one on either side of the main engine-room. Between them is the switchboard containing the generator switchgear, and thirteen 100-amp. change-over switches for putting any circuit on to either machine. From the circuit switches mains run to section boxes, and thence to sub-section fuse boxes, each of which feeds not more than 6 lamps; the fuse boxes in the accommodation quarters are in glazed teak cases, those in more exposed positions being of cast iron lined with asbestos. The mains and sub-mains are lead-covered, armoured and braided, those running fore and aft from the engine having an additional protection of steel troughing. For branch wiring twin 7/23 lead-covered wires are used, but in the engine- and boiler-rooms they are armoured in addition. The installation consists of 716 16-c.p. lamps, 87 small fans, and 5 2½-h.p. Sirocco fans. H. F. H.

ELECTRIC LAMPS AND LIGHTING.

699. *Brockie's Divided-lever Arc Lamp.* (Brit. Pat. 10,610 of 1906. Engineering, 83. p. 567, April 26, 1907. Abstract.)—In this lamp, which is chiefly designed to form one of a number of enclosed arcs burning in series, the rocking lever controlled by the core of the regulating solenoid is arranged coaxially with a lever which is connected by a link to the clutch, and which bears at one side of the fulcrum by means of a pin on the top of the core-lever, so that the clutch can be raised by the regulating solenoid in the usual way. The other side of the clutch-lever is provided with a latch or upwardly yielding projection, which is adapted to be struck by a hammer consisting of the core of a solenoid. This core is held up so long as the current is of a suitable value; if, however, the current falls to such a value as to render it necessary to restart the arcs, the hammer falls and rocks the clutch-lever through the latch so as to separate the carbons sufficiently to break the circuit, the pin on the clutch-lever meanwhile rising above the core-lever. The hammer then falls below the latch, so as to release the clutch-lever and thus enable the carbons to come together again to restart the arcs. When the arcs are struck again the hammer returns to its normal position, the latch yielding upwardly for this purpose. C. K. F.

700. *The Absorption produced by Frosted Globes.* **A. E. Kennelly.** (Electrical World, 49. pp. 987–988, May 18, 1907.)—In connection with the experimental results obtained recently by Cravath, Lansingh, and Millar [see Abstracts Nos. 642 (1906) and 587 (1907)] the author develops a simple quantitative theory which explains the results obtained. It is founded on the following statement taken from Millar's paper. The diminution in c.p. is undoubtedly due to "the action of the increasingly dense carbon deposit in absorbing a gradually increasing proportion of the light which the frosted

surface reflects and diffuses internally." Let us suppose that the lamp filament emits one lumen and that a is the transparency factor of the envelope. If the bulb were of clear glass a lumens would be emitted. Let us now suppose that the diffusion coefficient of frosting is m. In this case the flux of light reaching the frosted external layer of glass on the first emergence is a lumens. There will therefore be ma lumens radiated into space and $a(1-m)$ will be reflected back. Proceeding in this way we see that the total flux Φ' of light externally radiated is given by—

$$\Phi' = am + a^3m(1-m) + a^5m^2(1-m)^2 \ldots = am/[1-a^2(1-m)].$$

If there had been no frosting $\Phi = a$. The "frost reduction factor" is Φ'/Φ, and this is therefore equal to $m/[1-a^2(1-m)]$. If $m=1$ (perfect translucency) the reduction factor is unity, and if $m=0{\cdot}5$ (perfect diffusion) the reduction factor is $1/(2-a^2)$. It is evident that the greatest diminution of c.p. due to frosting occurs when $m=0{\cdot}5$, that is, when the diffusion is perfect. The following table shows how the frost reduction factor r varies with the transparency-coefficient a in this case :—

a ...	1	0·95	0·90	0·85	0·80	0·75	0·70	0·65	0·60	0·55	0·50
r ...	1	0·912	0·842	0·783	0·735	0·696	0·662	0·634	0·610	0·590	0·572

It appears from the above table that if the initial transparency of a clear globe be 0·95, corresponding to 5 per cent. absorption, the frosting reduction factor is 0·912 representing a further diminution of 8·8 per cent. due to frosting and the diffusion which is thereby produced. It is to be noticed that in no case can the reduction factor fall below 0·5. If we assume that the value of m, the diffusion coefficient of frosting, in Millar's experiments was 0·57, the calculated values agree well with the observed values. If the lamps are unfrosted the frosting loss is zero, but the brilliancy of the glowing filament is unpleasant to the eye. If we could frost to the limit $m=0{\cdot}5$ of pure diffusion we should cease to see the outlines of the glowing filament and only see the luminous bulb, but the frosting loss for a transparency of 10 per cent. would be 16 per cent. A compromise should be aimed at between obtaining perfect diffusion and having excessive frosting losses. The author considers that it is hardly worth while to extend his theory to the case of partially frosted bulbs. [See also Abstract No. 586 (1907).]

A. R.

701. *Effect of Use of Metallic Filament Lamps on Central Stations.* **H. V. Forest.** (Electrical World, 49. pp. 685–686, April 6, 1907.)—As a result of the investigations here made it appears that, in cases where a fixed annual charge is made for each lamp installed, the introduction of metallic filament lamps would raise the renewal costs 2½ cents per 40-c.p. lamp per month and save in coal 7·5 cents per lamp per month, giving a net saving of 5 cents each. With plants supplying current by meter it is recommended that a higher rate should be charged; this may be done by temporarily lowering the turning-point or quantity of current at which the price changes from the high to the low rate.

C. K. F.

REFERENCES.

702. *Revised Wiring Rules of the Institution of Electrical Engineers,* 1907. (Pp. 5–38, 1907. Electrician, 59. pp. 61–63, April 26, 1907. Extract.)—The extract deals with the chief differences between the old and the new rules.

703. *Safety Regulations of the Verband Deutscher Elektrotechniker.* (Elektrotechn. Zeitschr. 28. pp. 445–452, April 25, 1907.)—The newly revised rules of the Verband relating to earthing, insulation resistance, machines, transformers, secondary cells, switchboards and switches, arc and incandescent lamps, cable systems, and the wiring of spaces containing excessive moisture, explosive gases, &c., and of theatres. [See also Abstracts Nos. 678 and 679 (1907).] A. H.

704. *Distributing Systems.* **A. H. Ford.** (Electrical World, 49. pp. 836–838, April 27, 1907. West. Electn. 40. pp. 368–369, April 27, 1907. Paper read before the Convention of the Iowa Elect. Assoc.)—A comparison of the various distributing systems at present in use, considered more particularly with regard to the cost of copper, voltage regulation, and suitability for a motor load. A. H.

705. *Use of Secondary Batteries on Alternating-current Networks.* (Elektrotechnik u. Maschinenbau, 25. p. 354, May 5, 1907.)—The Siemens-Schuckert Works make use of an induction motor working with a large amount of slip and coupled to a shunt-wound dynamo, so designed as to work on the straight portion of its characteristic [D.R.-P. 180,449]. A. H.

706. *Spokane and Inland Single-phase Railway.* (Street Rly. Journ. 29. pp. 725–727, April 27, 1907.)—A few supplementary notes on this railway, the main features of which were noticed in Abstract No. 1219 (1906), and which is now in successful operation. A. H.

707. *Electrification of Main Line Railways.* **B. J. Arnold.** (West. Soc. Engin., Journ. 12. pp. 1–12, Feb., 1907.)—In a presidential address the author briefly describes the progress made in converting steam railways to electrical operation during 1906, mainly in the United States. [See also Abstract No. 686 (1905).] A. H. A.

708. *Design for Railway Track, based upon a Study of the Stresses in Track Superstructure.* **O. E. Selby.** (Eng. News, 57. p. 186, Feb. 14, 1907. Abstract of paper in Bull. No. 80, Amer. Rly. Engin. and Maintenance of Way Assoc., Oct., 1906.)—In this paper the author considers stresses to which railway permanent way is subjected, and applies these results in connection with the design of a permanent, or at least more durable structure. C. E. A.

709. *Rail Fractures in New York State.* (Eng. News, 57. pp. 493–494, May 2, 1907. From a bulletin issued by the New York State Railroad Commission.)—Numerous tabulated figures are given. The average numbers of fractures per mile were, in 1905, 0·14 ; 1906, 0·09 ; 1907, 0·33, in the first quarters of the years. Fractures occurred most frequently in the heaviest rails commonly used. It appears that faulty rails usually break within the first two or three years after laying. The proportion of rails which break at a greater age is small. F. R.

710. *Planning and Construction of the Power Plant.* **A. E. Dixon.** (Eng. Mag. 31. pp. 722–727, Aug. ; 909–934, Sept. ; 32. pp. 58–86, Oct. ; 227–247, Nov. ; 370–390, Dec., 1906 ; 551–571, Jan. ; 749–768, Feb., and pp. 860–878, March, 1907.)—The sections deal with Location, storage, and handling of fuel ; Boilers ; Stokers and chimneys ; Natural and mechanical draught ; Main and auxiliary machinery ; Gas engines and gas generators ; Design and arrangement of the central-station building. Profusely illustrated.

711. *Friedenau Electricity Works.* **M. Mulertt.** (Elektrotechn. Zeitschr. 28. pp. 126–131, Feb. 7, 1907. Elect. Engineering, 1. pp. 559–562, March 28, 1907.)—A small station employing Diesel engines. Two 250–300-h.p. sets are installed. Three-wire 440-volt distribution, with battery.

712. 11,000-*volt Single-phase Railway in Colorado.* (Electrician, 58. p. 917, March 29, 1907. From the "Electric Rly. Review.")—A new single-phase line is shortly to be opened in Colorado. Power is to be obtained from the generating station at 11,000 volts, and is to be supplied at this voltage to the trolley wire, no feeders or transformer substations being required along the line. The catenary suspension is to be used for the trolley wire. The rails weigh 85 lbs. per yard, slag being used for ballast. The speed is to be 60 m.p.h. A. H.

713. *Recent Progress in Heavy Electric Railway Work at Philadelphia.* (Street Rly. Journ. 29. pp. 276–285, Feb. 16, 1907.)—Details of the track and third-rail construction on the Subway and the Elevated Sections of the Philadelphia Rapid Transit system, supplementary to the previous description [Abstracts Nos. 237, 849 (1906)].

714. 100,000-*kw. Steam Turbine Station for Chicago.* **J. C. Thorpe.** (Power, 26. pp. 715–728, Dec., 1906.)—The Fisk Street station [Abstract No. 146 (1904)] is to have added to the four 5,000-h.p. units now running, ten 8,000-h.p. turbo-generator sets.

715. *Ventilation of the Boston Subway.* **H. A. Carson.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 50–64, Oct.; Discussion, pp. 459–462, Nov., 521–535, Supplement to Nov., 1906; 958–961, Jan., 1488–1489, May, 1907.)

716. *Electric Traction on Railways.* **P. Lanino.** (Atti dell' Assoc. Elettr. Ital. 10. pp. 100–109, Sept.-Oct., 1906.)—An address to an annual meeting discussing in general terms the future of single-phase and other systems of electric traction. A. E. L.

717. *Maximum Live-load Bending Moments and Shears for Bridges carrying Electric Cars.* **F. P. McKibben.** (Eng. News, 57. pp. 372–378, April 4, 1907.)

718. *Regenerative Control of Tramcars and Electric Locomotives.* **A. Raworth.** (Inst. Elect. Engin., Journ. 38. pp. 374–386; Discussion, pp. 386–398, April, 1907. Paper read before the Leeds Section. Electrician, 58. pp. 290–292; Discussion, pp. 292–293, Dec. 7, and p. 378, Dec. 21, 1906. Abstract.) [See Abstracts Nos. 2355, 2906 (1904) and 1282 (1905).] The results of some more recent tests are given.

719. *Extensible Gauge Tramcar Truck.* (Elect. Engineering, 1. pp. 723–724, April 25, 1907. Tram. Rly. World, 21. pp. 388–389, May 2, 1907.)—Photographs of a truck, devised by C. J. Spencer and J. W. Dawson, of the Bradford Corporation Tramways, by means of which the same car can be used on a 4-ft. gauge as on the standard 4 ft. 8½ in.; a simple distance block being raised when it is required to change the gauge of the wheels. L. H. W.

720. *Size and Voltage of Cells for Electromobiles.* **F. B. Rae.** (Electrical World, 48. pp. 1151–1152, Dec. 15, 1906. Motorwagen, 10. pp. 55–57, Jan. 31, 1907.) —A somewhat theoretical consideration of the respective advantages of 12-cell, 24-cell, 32-cell, and 40-cell batteries in electromobiles from the point of view of cost of charging and renewals. Of rather local interest. W. R. C.

721. *Use of Aluminium Rectifiers in Train-lighting Systems.* **M. Büttner.** (Zeitschr. Elektrochem. 12. pp. 798–808, Nov. 2, 1906.)—The author describes very fully the construction and use made of aluminium cells on the Prussian State Railways in connection with train-lighting. Numerous curves of results of tests are given. The cells are only used as valve cells and not for rectifying alternating currents. L. H. W.

TELEGRAPHY AND TELEPHONY.

722. *Steno-Telegraphy.* (Electrician, 59. pp. 188–189, May 10, 1907.)—This is a process owned by the Steno-Telegraphy Co., of London, intended to effect a degree of economy and efficiency in submarine cable transmission hitherto unattainable. The following particulars are by A. C. Baronio, the inventor of the Stenocode System. Whereas on the perforated slip, as now used in automatic signalling, only a single row of signalling perforations is employed on each side of the central or zero line, on the Stenocode slip an extra row of perforations is arranged upon a line on one side of and parallel to the central line. These extra perforations, when they occur, actuate a device for changing the battery power simultaneously with the contact which sends the current

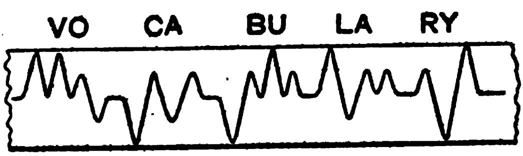


Fig. 1.

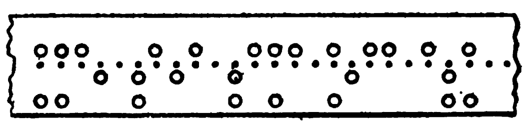


Fig. 2.

into the cable; but when no such extra perforation occurs the normal battery power alone is used, as at present. This enables the apparatus to be available for the transmission of the existing code also, and gives an advantage which would, of course, be of practical value during the period of change from the use of one code to that of the other. The Stenocode perforator is designed so that the extra perforation of the tape, when wanted, is made simultaneously with the dot or dash perforation, as the case may be. It is a five-keyed perforator, all the five keys being in use when the extra row of perforations is wanted, and only three when the present normal perforations are required. It is so arranged as to be manipulated by the four fingers and thumb of one hand, so that the operator at the punching-up station need never take his eye off the copy before him. At the intermediate stations messages are recorded either by the Stenocode apparatus or by siphon recorder in the ordinary way, or a facsimile slip is reproduced punched up ready to be fed through another transmitting instrument. If necessary a printing device can also be used to record the message. Fig. 1 is a siphon recorder slip with the vowels superimposed, Fig. 2 the corresponding perforated slip, showing the extra line of holes which put on the extra battery power for superimposing the vowels. This diagram shows how, in practice, the ideas put forward can be applied. Further methods of abbreviation are described. A complete apparatus on this system will, if desired, be exhibited at the International Telegraph Conference, Lisbon, next year. E. O. W.

723. *The Rowland Telegraphic System.* **L. M. Potts.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 409–440, April, 1907.)—This was described in Abstracts Nos. 2059 (1901) and 884 (1903). The account of the Potts synchroniser now in use is of interest. This synchroniser consists of a small direct-current shunt motor. On a shaft driven by this motor is mounted a trailer which passes over a crown commutator having alternate segments electrically connected. This crown commutator has such a number of segments that each segment corresponds to a half-wave of the alternating current used for signalling. The effect of this brush arm and commutator is identical with that of the vibrating tongue of a relay. The alternate segments of this crown commutator are connected to the two contacts of the synchronising end of the main-line relay. In series with the armature of the motor is a resistance, one side of which is connected to the synchronising tongue of the main-line relay. The other terminal of this resistance is connected to the trailer. The tongue of the main-line relay is kept in continuous vibration by the alternating current from the distant station, and the trailer is kept in continuous rotation by the motor. If the tongue of the relay is on the side contact which is connected to the set of segments of the crown commutator which the trailer is touching at the same time, the resistance is short-circuited; while if the tongue of the main-line relay is on the other side contact of the relay, the resistance will be in series with the armature of the motor. In the one case the armature will receive a much larger current than in the other. As a result, while the relay tongue is vibrating in unison with the rotation of the brush arm, there can be various amounts of current flowing through the armature of the motor, depending upon the relation of the relay tongue and the brush arm. (This relation is spoken of as the phase-difference). A mercury flywheel damper is provided, by which the synchronism can be maintained for a whole day. As synchronism indicators two devices are used—a telephonic one and a synchronising lamp. The lamp gives a steady light at synchronism.

E. O. W.

724. *Telephone Cable in the Königssee.* **O. Hintermayr.** (Elektrotechn. Zeitschr. 28. pp. 428–430, April 25, 1907.)—A description is given of the construction and mode of laying a cable manufactured by Felten and Guilleaume. There are eight copper conductors, each 0·8 mm. diam., making four pairs. The wire is insulated with three wrappings of cotton impregnated, sheathed with two lead tubes respectively 1·8 and 0·7 mm. thick, served with asphalted paper and compound, armoured with closed profile iron sheath, and compounded twice over all. The outside diam. of the cable is 34 mm. The insulation is 1,400 megohms per km. Communication with Munich with this cable in circuit is good. The shore ends of the cable are protected by being enclosed in split iron pipes, flanged, and of which the two halves are secured by grips and wedges. E. O. W.

725. *Sterilisation and Preservation of Telephone and Telegraph Poles.* **H. P. Folsom.** (Elect. Rev., N.Y. 50. pp. 713–714, May 4, 1907. Abstract of Address to Ohio Independent Telephone Assoc., March 28, 1907.)—Wooden poles initiated decay at or near the soil line. The author claims to have cured the rot by scraping away the decayed parts and applying antiseptic chemicals. The nature of these is not stated. In addition he placed round the pole a specially constructed jacket made of pliable asbestos, and a cap over the top of the jacket. An experience of six years has shown that the decay has been completely arrested. E. O. W.

SCIENCE ABSTRACTS.

Section B.—ELECTRICAL ENGINEERING.

JULY 1907.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

726. *Test of a 3,500-kw. Parsons Turbo-alternator.* (Eng. Rev. 16. pp. 430–431, June, 1907. Elect. Rev., N.Y. 50. p. 940, June 8, 1907. Street Rly. Journ. 29. p. 1018, June 8, 1907.)—Particulars are given of a test carried out by C. H. Merz on one of four similar turbo-generators for the Carville Power Station, Newcastle-on-Tyne. The trials were made after the machine had been at work for over six months. The best result obtained, at 5,164 kw., was a steam consumption (by weighing) of 13·189 lbs. per kw.-hour, which is equivalent to 7·85 lbs. per i.h.p.-hour, and is considered to be probably a record performance. The arrangements adopted for the test are described. The chief results are given below.

Duration of Test (Hours).	Mean Calibrated Kw.	Steam.			Speed R.P.M.	At Turbo Exhaust.	Water.
		Pressure.	Temperature at Turbo °F.	Superheat °F.		Vacuum at 30 in. Brm.	Lbs. per Kw.-hour.
½	No load, not excited	180	460	80	1,200	28·875	—
½	No load, excited	211	453·3	61	"	28·95	—
1	2192·87	202·4	492·1	103	"	29·036	14·517
1½	4045·14	197·4	495	108	"	29·066	13·839
1½	5901	195·8	503·2	117	"	28·95	13·464
½	6921·8	198·4	505·5	118·5	"	28·765	13·692
1	5164·07	199·9	508·5	120·5	"	29·039	13·189
3	5059·38	194·5	477·9	92	"	29·195	13·411

L. H. W.

727. *Piston Engine versus Turbine.* **W. A. Müller.** (Zeitschr. ges. Turbinenwesen, 4. pp. 221–222, May 20, 1907.)—It is usually stated that the steam turbine unit cannot compete with the piston engine unit below powers of 500 h.p., the steam consumption being greater in the case of the turbine below this power. The steam consumption is, however, not the only factor

to be considered. The author states a case of a 200-h.p. installation. The lowest quotation for a 200-h.p. piston engine was £1,295, including condenser plant, delivered on site. The steam consumption was given as 5·6 kg. per h.p.-hour at full load, and a steam pressure of 9 kg. per sq. cm., or about 10 kg. per kw.-hour, with belt drive to dynamo. The turbine quotation was £1,360, delivered, for a 150-kw. (225-h.p.) installation, including direct-coupled generator, but not the condenser plant. Steam consumption was given as 10·9 kg. per kw.-hour at 9·8 kg. per sq. cm. steam pressure. The total installation costs are given in Table I., and the working costs in Table II.,

TABLE I.

Comparison of Installation Costs.

Piston Engine.	£	Steam Turbine.	£
200-h.p. piston engine, Condenser plant ...... } delivered on site...	1,295	225-h.p. steam turbine ......, 150-kw. continuous-current dynamo........ } delivered on site	1,360
135-kw. continuous-current dynamo	615	Condenser plant..........	397
Erection of machines and condenser plant	80	Erection of machines and condenser plant	73
Dynamo belt	45	Foundations for turbo set and condenser plant	62·5
Foundations for machines and condenser plant	100	Alterations to building	7·5
Alterations to building (at least)	65		
Total	£2,200	Total	£1,900

TABLE II.

Comparison of Working Costs.

Piston Engine.	£	Steam Turbine.	£
Interest and Depreciation (10 per cent.)...	220	Interest and Depreciation (10 per cent.)	190
Annual coal consumption at 135 kw.	532	Annual coal consumption at 135 kw.	582
Lubricating oil, cleaning, and packing material	58	Lubricating oil, cleaning, and packing material	8
Total	£810	Total	£780

neglecting such items as would be the same in both cases. The comparison is favourable to the turbine in both capital and working cost. H. M. H.

728. *Progress in the Development of the de Laval Turbine.* F. Langen. (Zeitschr. ges Turbinenwesen, 4. pp. 101–102, March 9; 119–122, March 20, and pp. 186–189, March 30, 1907.)—The thermodynamic efficiencies of various types of steam turbines of capacities not exceeding 575 h.p. are compared, and it is shown that the de Laval type has the highest efficiencies. When used as prime movers for generators a friction drive is recommended for de Laval turbines of 30 h.p. and less, in the interests of quiet running. The author considers it better to employ direct-connected dynamos, and believes that cheaper and lighter machines are thus rendered practicable. A table of continuous-current 2-pole dynamos designed for direct connection (*i.e.*, without *any* speed reduction gearing) to de Laval turbines of outputs ranging from 1 to 200 kw. is given. The constants for these designs depart from those of the slower types of turbine generators most markedly with respect to the peripheral speeds, which reach exceedingly high values. The armature peripheral speeds range from 94 to 180 m.

Output in kw.	1·0	3·3	6·6	10	20	30	50	100	200	400
Output in h.p.	1·5	5·0	10	15	30	45	75	150	300	600
Revolutions per minute	30,000	30,000	24,000	24,000	20,000	16,000	16,000	12,000	10,000	10,000
Armature diameter	60	60	90	90	120	150	150	200	250	For this rating two 200-kw. machines are employed
Armature gross core length	47	93	78	100	108	124	170	180	250	
Shaft diameter, cm.	12	12	15	17	20	25	25	30	35	
Armature peripheral speed, m./sec.	94	94	113	113	125	125	125	125	130	
Commutator diameter, cm.	35	35	40	40	50	60	60	90	120	
Commutator peripheral speed, m./sec.	55	55	50	50	52·5	50	50	56·5	63	
Voltage range, E	58–115	58–115	58–115	115–230	115–230	115–230	115–230	230–460	500–600	{ 500–600 1,000–1,200
Number of slots	12	12	18	14	20	32	24	40	34	
Number of conductors (for E max.)	216	96	72	112	80	64	48	80	68	
Number of commutator segments	18	24	18	28	40	32	24	40	34	
Conductors per segment	12	4	8	4	2	2	2	2	1[1]	
Flux per pole, megalines	0·11	0·25	0·411	0·538	0·90	1·40	1·88	3·0	5·30	
Pole face density, kilolines	3·6	4·1	5·4	5·4	6·2	6·8	6·8	7·6	7·75	
Armature core density, kilolines	9·8	10·5	13·0	13·0	12·8	13·9	13·7	14·2	15·0	
Max. tooth density, kilolines	12·6	18·5	17·0	17·6	17·8	17·4	17·8	19·8	20·9	
Radial depth of air-gap	4	5	6	7	8	10	10	12	13	
Amp. T's for gap for both poles	2,830	3,600	5,600	6,500	8,700	12,000	12,000	14,400	16,000	
Amp. conductors per cm.	54	78	78	92	98	95	117	147	147	
Current density, amps. per sq. cm.	600	600	630	600	580	550	510	480	416	
Armature copper loss in per cent.	2·6	1·5	1·35	1·15	1·05	0·8	0·65	0·55	0·4	
Armature iron loss in per cent.	3·5	2·5	2·75	2·5	2·1	2·0	1·6	0·95	0·82	
Commutator C^2R loss in per cent.	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·25	0·1	
Commutator friction loss in per cent.	0·55	0·55	0·5	0·5	0·53	0·5	0·5	0·28	0·15	
Friction and windage loss in per cent.	4·5	2·7	3·2	2·8	2·3	2·4	1·9	1·45	1·3	
Shunt winding loss	2·5	1·2	1·0	0·8	0·6	0·5	0·35	0·2	0·15	
Efficiency of dynamo in per cent.	85·9	91·0	90·7	91·8	92·9	93·3	94·5	96·3	97·1	

[1] This 200-kw. machine has two commutators.

per sec., and the commutator peripheral speeds from 55 to 63 m. per sec. In order to keep the core loss small, special laminations 0·3 mm. thick and with low hysteresis loss are used. Totally closed over slots, long air-gaps, and interpoles are employed in these designs. For a 200-kw. generator at 500 volts and 10,000 r.p.m. it is considered necessary to employ two commutators to keep the sparking within practicable limits. On account of the poor contact caused by vibration, and also on account of the high losses, carbon brushes are considered impracticable at these very high peripheral speeds, therefore copper-foil brushes are provided. The following table gives the price of geared de Laval generating sets :—

H.P.	Kw.	Price in Shillings.	
		Without Dynamo.	With Dynamo.
5	3·3	1,300	1,800
10	6·6	2,000	2,800
30	20	3,000	4,650
50	33	5,000	7,500
100	66	8,000	12,700

A 10-kw. direct-connected set at 24,000 r.p.m. would probably cost 2,000 shillings, this being some 800 shillings cheaper than the geared set. The author states that the turbo-dynamos of the A.E.G. cost for the 2, 5, 10, 15, and 20-kw. sizes, 3,680, 4,480, 6,000, 7,750, and 9,180 shillings respectively. The data of the direct-connected designs prepared by the author are given in the accompanying table. H. M. H.

729. *Tests on a 2,000-H.P., 3,000-R.P.M. Riedler-Stumpf Steam Turbine.* **F. Rötscher.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 605–613, April 20; 658–665, April 27, and pp. 707–710, May 4, 1907.)—The author gives full descriptions of some exhaustive tests which he has carried out on the above turbine, and draws interesting conclusions from the results obtained. A short description of the turbine is given. The steam consumption at full load, 13 kg. per sq. cm. steam pressure, 85 per cent. vacuum, and about 96° C. superheat was 9 kg. of steam per kw.-hour, increasing to 10 kg. per kw.-hour when the load was reduced to 40 per cent. of full load by throttling the steam. A hydraulic brake designed by Stumpf, and used in the experiments is described in the article. Experiments were made to determine the influence of varying speed and steam pressure on the steam consumption. The influence of the construction of the nozzle on the temperature, pressure, and velocity of the steam jet is considered mathematically, and the results are shown graphically. Curves showing temperature, pressure, velocity and friction loss in different parts

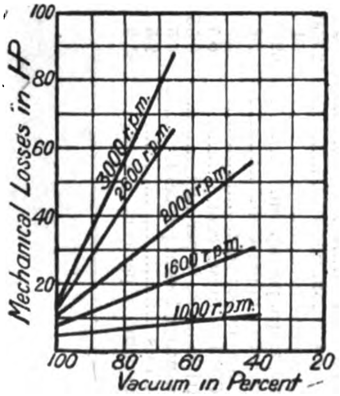


Fig. 1.

of the nozzle are given. In Fig. 1 the mechanical losses in the turbine are shown for various degrees of vacuum and at various speeds, the loss at 100 per cent. vacuum being the loss due to bearing friction. The steam friction loss which is represented at any point by the height of the ordinate minus the corresponding bearing friction loss, is found from these curves to increase as the 2·8th power of the speed, this value agreeing well with that found by Stodola, *i.e.*, the 2·9th power. The various losses are then considered in detail, and three interesting diagrams are given, showing

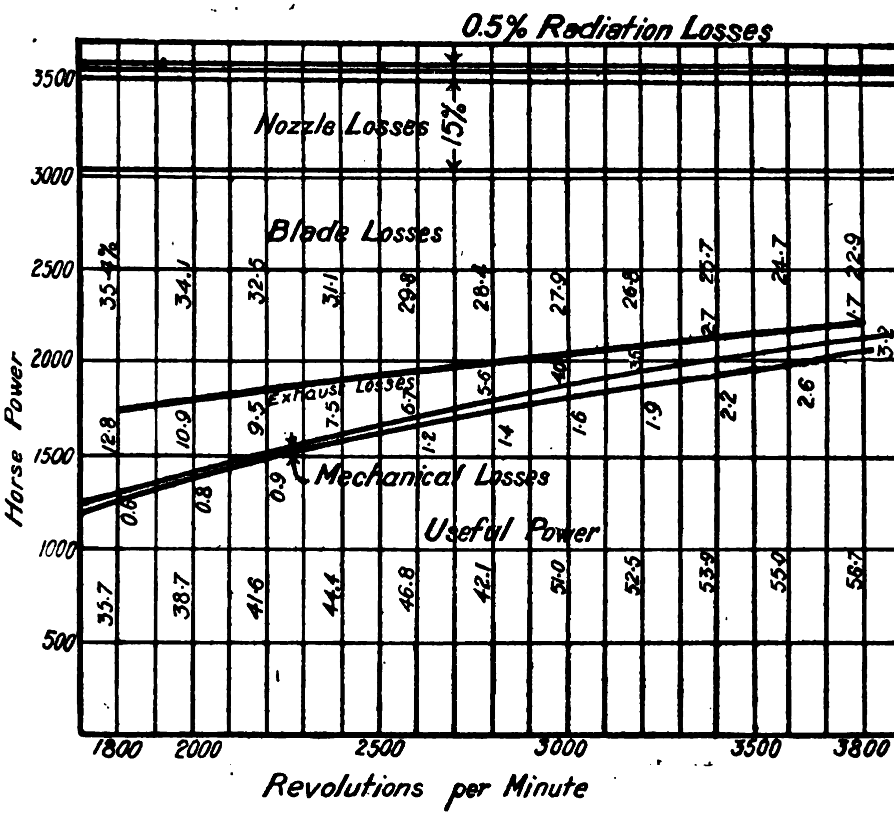


FIG. 2.—LOSSES IN TURBINE AT 14 ATM. ABS. ADMISSION PRESSURE 91% VACUUM 70% SUPERHEAT.

the variation in the relative values of the percentage losses for different speeds, the three diagrams being for 14, 11, and 7 atmos. abs. admission pressure. The first of these diagrams is reproduced in Fig. 2. The uppermost horizontal line represents the theoretical power which is the same at all speeds. The various losses are set off downwards. The first is the loss by radiation, about 0·5 per cent. at all speeds. The second is the loss by friction in the nozzle, which is about 15 per cent. at all speeds. The next is the loss due to the friction between the entering steam and the revolving blades, which decreases with increasing speed of the blades, varying between 35 and 28 per cent. Added to this is another steam friction loss, the friction loss at the exhaust,

also decreasing with increasing blade velocity, and varying between 18 and 2 per cent. Finally, we have the mechanical losses (those represented in Fig. 1), which increase with increasing speed, but which are not large, and varying from 0·5 to 8·5 per cent. The thermodynamic efficiency of the turbine is thus 51 per cent. at 8,000 r.p.m., rising to 56·7 per cent. at 3,800 r.p.m. The investigation is very elaborate, and a great amount of data is given. H. M. H.

730. *Steam Friction in Steam Turbines.* **G. Belluzzo.** (Zeitschr. ges. Turbinenwesen, 4. pp. 219–221, May 20, 1907.)—The friction losses in turbines of the Rateau, Zoelly and Curtis types consist of journal friction, friction between the steam and rotating surfaces and friction due to the steam eddies between the blades. The loss due to friction between the steam and the rotating surfaces can be reduced to a very small amount by ensuring that these surfaces are perfectly smooth; the loss due to the steam eddies depends upon the shape and size of blades and cannot be reduced below certain considerable amounts. The curves in Fig. 1 are the results of experiments on two turbine wheels each of 2·1 m. diam., driven at a constant speed of

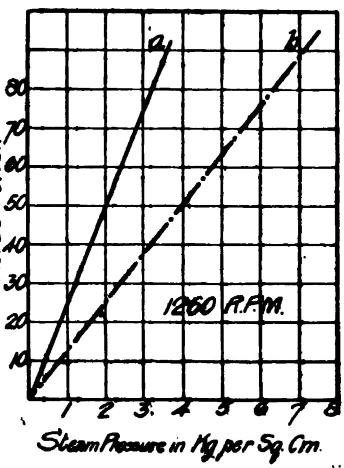


FIG. 1.

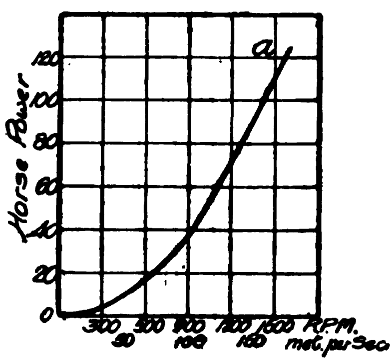


FIG. 2.

1,200 r.p.m, in their cases, in dry saturated steam at various pressures. Curve *a* is for a wheel with larger blades than those of the wheel represented by curve *b*. The abscissæ denote steam friction loss in h.p., the bearing friction loss having been subtracted. It will be seen that the loss increases directly with the density of the steam. Fig. 2 shows the same loss expressed as a function of the speed. This curve was plotted from results obtained with another wheel of the same diam., but with twice the number of blades, run in its case. The case was open to the atmosphere, the density of which corresponded to that of steam at a pressure of 2·8 kg. per sq. cm. The losses in this case increase rapidly with increasing speed. By a method explained in the article the friction loss at 1,200 r.p.m. in the atmosphere (corresponding to 2·8 kg. per sq. cm. steam) was resolved into its two components, the loss due to friction between steam and rotating surfaces being about 7 h.p., only 10 per cent. of that due to the blades which was about 70 h.p. H. M. H.

731. *Recent Test Results on Steam Turbines.* **F. Langen.** (Zeitschr. ges. Turbinenwesen, 4. pp. 215–216, May 20, 1907.)—Since the publication of the author's recent article on the Economy of Steam Turbines and Piston Engines [Abstract No. 236 (1907)] a number of more recent results have been published. These are set forth in the following table:—

Number.	System.	Remarks.	Source.	B.H.P.	Kw.	Dynamo Efficiency.	Calories per kg.	Temperature in Degrees Cent.	Thermo-dynamic Efficiency.
1	Elektra ...	1 stage	Z. f. Turb. 07, p. 98	40	—	—	174	250	37·3
2	Elektra ...	2 „	Z. f. Turb. 07, p. 98	100	—	—	182	250	47·4
3	Elektra ...	2 „	Z. f. Turb. 07, p. 98	300	—	—	204	290	48·8
4	Parsons ...	4,000 r.p.m.	Z. f. Turb. 06 (524)	385	—	—	170	302	65·5
5	Parsons ...	Gustav Pit	Z. f. Turb. 07 (37)	1,100	--	93	184	300	64·2
6	Rateau ...	1,500 r.p.m.	Z. d. V. d. Ing. 07 (419)	1,460	1,000	93	227	300	54·8
7	Gutehoffnungshütte	Exhaust steam	Z. d. V. d. Ing. 07 (397)	1,580	1,112	94·6	79·7	—	80
8	A. E. G. ...	—	Stahl und Eisen 07. S. 121 bis 126	1,820	1,250	93·5	206·5	300	62·3
9	A. E. G. ...	Berl. Electricity Works	Z. d. V. d. Ing. 07, (387)	4,580	3,182	95·5	225	309	69·5
10	Parsons ...	Frankfort	Stodola II. 246	4,280	2,995	95·0	198·5	312	68·6

The individual results are successively commented upon in the course of the article, and the general conclusion is that slight but nevertheless certain progress towards higher thermodynamic efficiencies has accompanied recent steam turbine developments, and that these have been most conspicuous in the case of turbines of the Parsons type. It is pointed out that for the conditions of exhaust steam working, however, the reaction type turbines are superior. The writer observes that since steam turbines may be designed to work with much lower exhaust pressure than is the case with piston engines, the steam consumption of the turbines is now in practice fully as low as that of the piston engines although the piston engines still show considerably higher thermodynamic efficiency. When, however, the conditions as regards supply and temperature of cooling water are not favourable, the steam turbine loses this advantage as compared with the piston engine. The writer states that exhaust pressures of less than 0·05 kg. per sq. cm. are only rarely attainable, and that where the circulating water has to be recooled by towers, an exhaust pressure of 0·10 kg. per sq. cm. may be taken as the extreme economic limit. Under this latter condition the piston machine still has the advantage over the steam turbine. H. M. H.

732. *Boiler-water Analysis.* **J. G. A. Rhodin.** (Engineer, 103. pp. 539–540, May 31, 1907.)—The author states that the usual methods of returning the analyses of boiler-feed waters, as "permanent" or "temporary" hardness are of little use for the practical engineer. The ingredients of a boiler-feed water that are of importance are those which cause: (1) scale formation; (2) pitting of the boiler-plates; (3) corrosion of the boiler fittings, and (4) priming. The first of these effects is produced by lime and magnesia salts, the second by certain magnesia and alkali salts, the third by free alkalies, and the fourth by alkali salts and especially by sodium sulphate. In order to

arrive at a judgment as to the suitability of a water for boiler use, the sample should be tested for the following: dissolved solids, magnesia as MgO, iron and aluminium as oxides, lime as CaO, sulphuric acid as SO_3, chlorine as Cl, and alkalinity as $CaCO_3$, and the results should be expressed as parts per 100,000. Samples should be taken and forwarded for analysis in Winchester quart glass bottles with well-fitting stoppers, covered and tied down with parchment paper. The remainder of the article is devoted to showing how the analytical results of typical waters are used for calculating the amounts of the salts which cause scaling, pitting, corrosion, &c., and what remedies are necessary in the form of softening chemicals to render these waters safe for use. The following figures are given as the limits above which feed-water must be submitted to some purification: Total solids, 30 parts per 100,000; lime and magnesia, 5 parts; sulphuric acid, 5 parts. J. B. C. K.

733. *Experiments on a Broken Boiler-plate.* **C. Bach.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 747–751, May 11, 1907.)—Gives the results of tensile and other mechanical tests of a plate from a Cornish boiler, which had failed under hydraulic test. The considerable opening of the crack, which followed the inner line of rivet-holes, was taken to indicate the existence of considerable internal tension. The metal in the neighbourhood of the outer rivet-holes, however, also showed small cracks. There was marked irregularity in the resistance of notched bending specimens to shock, which indicates poor material. The plate was found to have a high sulphur content, and S was also unusually segregated. Etched micro-specimens exhibited a strained structure characteristic of incipient cracking. F. R.

734. *Formulæ for calculating the Calorific Value of Fuels.* **E. Lenoble.** (Bull. Soc. Chim. 1. pp. 111–114, 1907.)—It is shown that Goutal's formula [see Abstract No. 252 (1908)], can be reduced to the form—

$$P = 82C + 78{\cdot}66V + 98CV/(C + 7V),$$

where P is the calorific value, C the percentage of ash-free coke, and V the percentage of moisture-free volatile matter. Almost the same results can be arrived at by employing the still simpler equation $P = 87{\cdot}4\,(100 - k)$, where k is the sum of the percentages of moisture and of ash, the latter based upon the dry coal. Both these formulæ are fairly accurate in the case of coals of medium quality, but should not be used for coals of over 8,500 kg.-cals.

L. H. W.

735. *Analysis of Lignitic and Sub-bituminous Fuels.* **A. J. Cox.** (Amer. Chem. Soc., Journ. 29. pp. 775–783, May, 1907.)—The author deals with the discrepancies obtained when determining the percentage of volatile matter and coke or fixed carbon in certain lignitic coals by use of the method advised by the Committee of the American Chemical Society and known as the official method of analysis. When coals of the class referred to by the author are exposed directly to the full heat of the Bunsen flame in a covered platinum crucible, the escaping gases carry off a large number of solid particles of fuel, and figures are given to show that this loss may cause differences of nearly 7 per cent. in the test results. The author has found that the loss may be avoided altogether by submitting the fuel to a careful preliminary heating or "*smoking off*" in the crucible, and the following instructions are given for carrying out his method: The sample is first subjected to a low heat, sufficient to keep a visible amount of smoke rising

from the crucible, but not enough to cause this smoke to ignite. The heat is regulated by holding the burner in the hand, and by slowly moving the flame backwards and forwards under the crucible. The crucible must not be allowed to cool after the heating is once commenced, as otherwise air will be drawn in, and oxidation of part of the coke will occur. No definite time can be fixed for the duration of this preliminary heating, as it varies with different coals, but the volatile matter should be driven off as fast as possible without the ejection of solid particles and without allowing the gases to become ignited at the edge of the crucible. When this expulsion of the hydrocarbons and hydrogen gas is completed, the remainder of the heating is carried out in the usual way according to the official directions. From 7 to 9 min. are generally necessary for the preliminary heating; and this is only applied in cases where a qualitative test of the fuel shows that it is required. J. B. C. K.

GAS AND OIL ENGINES.

736. *Gas-producers.* **J. Körting.** (Stahl. u. Eisen, 27. pp. 685–718, May 15; Discussion, pp. 800–807, June 5, 1907. Paper read before the Hauptversamml. des Vereins deutsch. Eisenhüttenleute, Düsseldorf, May 12, 1907.)—The author in this lengthy paper gives first some historical details relating to the development of the modern gas-producer, and then discusses the scientific and practical sides of the subject. Under the former he states that the formation of CO from CO_2 occurs most satisfactorily at a temperature of 1,000° C., and that at 450° C. it practically ceases. As regards the use of water or steam, he shows that each variety of fuel requires different treatment in this respect, and that brown coal or lignite carries so much water naturally that no addition is required to attain the best results. It is stated to be almost impossible under working conditions to obtain the decomposition of all the water passed through the producer, and in those cases where a high temperature is required it is advisable to remove, by cooling below 100° C., this excess of undecomposed water from the producer-gas before use. A large number of analyses are given to show the composition of the gas obtained from different types of producer, with and without the use of water or steam. In the portion of the paper dealing with the gas-producers in actual use, all the more important types of producer manufactured in Germany are illustrated and described. The last of these is a four-shaft or ring producer designed by Jahns, for the gasification of the poorest and most worthless forms of bituminous fuel. The special features of this type of generator are that the gas passes through three of the four shafts before leaving the generator, and that the whole contents of one shaft are discharged when the carbonaceous matter is completely burnt off. The large mass of hot ashes are retained below the generator shaft and serve to heat the air passing to the new charge of fuel. With this producer, colliery and other refuse containing on the average 60 to 65 per cent. of ash and only 25 per cent. of carbonaceous matter, can be completely gasified. The average thermal value of this refuse is 2,400 kg.-cals. (4,820 B.Th.U.), and the thermal value of the gas obtained is from 987 to 1,188 kg.-cals. The composition of the gas is as follows: CO_2, 12·6 per cent.; CO, 18·10 per cent.; CH_4, 0·90 per cent.; H, 27·0 per cent.; O, 0·057 per cent. The gas can be obtained practically free from tarry matter. The author regards this use of refuse that hitherto has been considered worthless by colliery owners for gas-producing purposes, an achievement of considerable importance. J. B. C. K.

737. *600-B.H.P. Horizontal Twin-cylinder Gas Engine.* (Mech. Eng. 19. pp. 823–825, June 15, 1907.)—This engine, of which a photograph and two longitudinal sections are given, is constructed by Mather and Platt, Ltd., for driving a ring spinning mill, great regularity of turning being required for this service, besides quick and certain starting against load without the use of clutch gear; the possibility of running at slow speed, down to 25 per cent. of normal, when necessary; accessibility of all parts from the engine-room floor and no parts below the floor-level. The general design of horizontal steam mill engines has been followed, the cylinder inlet valves being operated by rolling levers worked by an eccentric on the crank-shaft. Exhaust is by means of ring ports in the power cylinder, which are uncovered by the piston. The engine is of the double-acting 2-cycle type, running at 115 r.p.m. with producer-gas. If used for direct-coupled dynamo driving and run at 185 r.p.m., 700 b.h.p. would be developed. Twin cylinders are placed one on each side of the grooved flywheel for rope driving, the cranks being 90° apart, and alongside each cylinder are two single-acting air pumps and a double-acting gas pump worked by the same piston rod coupled to a connecting-rod and crank. The mechanical efficiency of the pumps is stated to be 84 per cent. Regulation of the engine is by quantity governing and the time of ignition can also be regulated by hand while the engine is running. F. J. R.

738. *Effect of Size on the Thermal Efficiency of Explosion Motors.* H. L. **Callendar.** (Mech. Eng. 19. pp. 698–701, May 18, and pp. 733–736, May 25, 1907. Paper read before the Inst. of Automobile Engineers, May 8, 1907.)—For the air-standard efficiency the author gives the formula $E = 1 - (1/r)^{0.40}$, in which r is the ratio of expansion or compression; and the ratio of specific heats of the gas being $\gamma = 1{\cdot}40$, the value of the index $\gamma - 1$ is $0{\cdot}40$. This is deduced from the ideal efficiency $= 1 - (1/r)^{\gamma - 1}$, and the following table gives results for values of γ of 1·40 and 1·30:—

IDEAL EFFICIENCIES. PERFECT GAS.

Ratio of Compression, r.	Air Standard Efficiency, $\gamma = 1{\cdot}40$.	Perfect Gas, for which $\gamma = 1{\cdot}30$.	Relative Efficiency, $\frac{\text{Gas}}{\text{Air}}$.
2	0·243	0·189	0·778
3	0·357	0·282	0·789
4	0·427	0·341	0·798
5	0·475	0·383	0·806
7	0·542	0·442	0·816

These results compare well with the relative efficiency as obtained by Clerk [see Abstract No. 904 (1906)], but his results should be corroborated by an independent method. Arguing from the conditions of loss of heat with variation in speed and temperature, the author reaches the conclusion that the loss of relative efficiency in similar engines of different size under equivalent conditions of running should vary inversely as the linear dimensions, or as A/D, when D is the diam. and A is an appropriate coefficient depending on the form of the surface. On this basis engines L, R, and X

of the Committee of the Inst. C.E. are compared with C, a small engine used in experiments by the author, A being taken as = 1, and D in inches :—

COMPARISON OF ENGINES OF DIFFERENT SIZES.

Designation of engine	C	L	R	X
Diam. of cylinder, inches	2·36	5·5	9·0	14·0
Loss of efficiency 1/D	0·42	0·18	0·11	0·07
Fraction realised (1 − 1/D)	0·58	0·82	0·89	0·93 [1]
Relative efficiency, obs.	0·44	0·61	0·65	0·69
Limit if no variable loss	0·77	0·75	0·73	0·74

[[1] Wrongly printed 0·03 in Mech. Eng.]

This indicates that the maximum limit attainable by a very large engine, in which the variable losses were negligible, would be about 75 per cent. of the air standard. The bearing of these considerations on rating formulæ is then considered, especially in view of the three principal factors unaccounted for in the Automobile Club rating, and tables are given of Comparison of rating formulæ assuming equal bore and stroke, Comparison of formulæ for piston speed, Power-rating by bore and stroke, and Variation of ratio of weight to power with size. In a summary of formulæ it is shown how the various formulæ should be modified to take account of different factors. F. J. R.

739. *Gardner's Internal Combustion Engine.* (Mech. Eng. 19. p. 748, May 25, 1907.)—The device patented by T. H. and E. Gardner, of Barton Hall Engine Works, Patricroft, is for varying the quantity of water injected along with the fuel charge simultaneously with variation in that charge. It consists of an automatic valve controlled by a piston working automatically in a cylinder under the influence of the suction intermittently produced in the main fuel and air supply passage. It is illustrated by vertical sections in two forms, one showing the admission of water along with the mixture of air and fuel, and the other showing the admission of water through a supplementary air valve. F. J. R.

740. *Air-cooling of Automobile Engines.* J. Wilkinson. (Amer. Soc. Mech. Engin., Proc. 28. pp. 1592–1596, June, 1907.)—In order to prevent overheating, with its attendant troubles, the most favourable conditions both internally and externally must be provided. The internal conditions are: (*a*) To present the minimum internal surface to the heat; (*b*) to make this surface as smooth as possible; (*c*) to carry off the hot gases at the bottom of the stroke before the main exhaust valve opens; (*d*) to get rid of what is left with as little surface contact with the cylinder as possible; (*e*) to reduce the friction of piston on the cylinder to a minimum; (*f*) to keep all projections out of the cylinder; (*g*) to make the compression such as to fit all other conditions. A hemispherical head offers much less surface than a valve pocket on either side of the cylinder, and its surface can be machined smooth. An exhaust port opening 40° before the end of the stroke, with an auxiliary exhaust opening at the same point, shows considerable improvement in power. Cards from the indicator of a 4-in. by 4½-in. engine with one and with both openings are given. The external conditions comprise best form of radiating surface and supply of air current. These still require working out. The air-cooled motor delivers in practice 1 h.p. for each 7·4 cub. in. displacement at 1,000 ft. per min. piston speed, and 1 h.p. for each 6¾ in. piston displacement will soon be realised. Tests show a heat efficiency of 20 per cent., or 0·7 lb. of gasoline per b.h.p.-hour. F. J. R.

741. *Gas-engine Efficiencies.* **L. Bairstow.** (Engineering, 83. pp. 731–732, June 7, 1907.)—Founded upon experiments on the specific heats of air, nitrogen, oxygen, carbon dioxide, and steam made by Holborn, Austin and Henning, at the Reichsanstalt, the author gives the following table of values for a mixture produced by the explosion of one part of gas to nine of air, the actual values of the specific heats being for 1 cub. ft. of mixture measured at 0° C. and 30 in. of mercury :—

Temperature, °C. θ.	Absolute Temp. t.	Mean Specific Heat from 0° C.	Specific Heat.	X.
		Foot pounds.	Foot pounds.	
0	273	—	19·6	1
100	373	19·6	19·7	2·23
200	473	19·7	19·9	4·14
300	573	19·9	20·1	6·62
400	673	20·1	20·6	10
500	773	20·2	21·2	14·6
600	873	20·4	22·0	20·6
700	973	20·6	22·9	28·2
800	1,073	21·0	24·0	38
900	1,173	21·4	25·2	50·3
1,000	1,273	21·9	26·4	65·8
1,100	1,373	22·3	27·7	85·3
1,200	1,473	22·8	29·0	109·5
1,300	1,573	23·3	30·3	140
1,400	1,673	23·9	31·6	178
1,500	1,773	24·5	33·0	226
1,600	1,873	25·1	34·4	286
1,700	1,973	25·6	35·8	361
1,800	2,073	26·2	37·1	455
1,900	2,173	26·8	38·5	573
2,000	2,273	27·5	39·1	719

The calculation of points on any adiabatic is readily carried out by means of this table, as the relation between the volume and X along any one curve is $v = c/X$, c being a constant determined by the conditions at any one point. Tables of values of v at temperatures (θ) from 100° to 600° C., and pressures (p) of 14·7 to 313 lbs. per sq. in. for compression curves; and for temperatures of 2,000° to 1,000° C. for adiabatic curves, with different ratios of expansion (r), are also given, and finally the following table of efficiencies corresponding to different values of r :—

r.	Efficiency, Air Standard.	Efficiency, Actual Working Gases.	Efficiency Relative to Air Standard.
4	0·426	0·335	0·787
5	0·475	0·384	0·809
6	0·512	0·417	0·815
7	0·541	0·445	0·823
8	0·565	0·470	0·832
9	0·585	0·490	0·837
10	0·602	0·508	0·845

In the paper and an appendix the steps in the various calculations are shown. [See also Abstracts Nos. 904 (1906), and 733 (1907).] F. J. R.

AUTOMOBILISM.[1]

742. *Gasoline Motor Cars for Railway Service.* **W. R. McKeen, Jr.** (Street Rly. Journ. 29. pp. 782–784; Discussion, pp. 784–785, April 27, 1907. Paper read before the New York Railroad Club.)—Deals almost entirely with the Union Pacific gasoline car [see also Abstract No. 677 (1906).] In the *discussion*, costs are dealt with and curves are given showing the cost per car-mile in cents for 0–1,200 car-miles per day for the steam locomotive, steam motor car, gasoline car, and electric car, from which it can be seen that for a small number of car-miles per day (up to 200) the electric car is the most costly (38½ cents), and the steam car, and next the gasoline car (at 15 cents per gall.) the cheapest, 16¼ and 22½ cents respectively; but for 400 car-miles per day the electric car costs the same as the gasoline car (21 cents, steam car 14¼ cents); and above this number of car-miles the cost of the electric car rapidly comes down to that of the steam car (13½ cents at something over 900 car-miles per day). L. H. W.

743. *Special Steels for Motor Cars.* **T. J. Fay.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 1745–1777, June, 1907.)—Gives numerous general observations upon steels in use for motor-car construction, with results of some analyses and tests. Summarising, the useful steels may be graded as follows, according to percentage composition :—

Grade.	Cr	Ni	C	Si, not over.	S, not over.	P, not over.	Mn, not over.
A	1·60	4·50	0·28	0·18	0·012	0·012	0·35
B	1·40	3·30	0·30	0·20	0·018	0·015	0·40
C	0·70	2·00	0·35	0·15	0·028	0·025	0·40

If S and P vary together, the elongation is inversely proportional to their amount, and the forging qualities follow elongation. It is stated that special steels are in general less liable to crack than carbon steels; the author has frequently observed carbon steel members cracked in car wrecks, but never alloy steels, however severely distorted. Many of the steels considered will not satisfactorily oil-harden, and need to be case-hardened; these are of composition, typified by Group A, above. Group A is more amenable to forging, and the effect of variations of the metalloid impurities have more effect upon steels of this class than on those of Group C. Any forging should be done in dies, and machining in the lathe as far as possible, for best and most economical results. F. R.

REFERENCES.

744. *Superheat and Furnace Relations.* **R. P. Bolton.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 1587–1591, June, 1907.)—Summarises existing conditions of superheater construction and working to show the necessity for a better co-relation between furnace and heat control and boiler and superheater design. [See also Abstract No. 599 (1907).] F. J. R.

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

745. *Entropy Lines of Superheated Steam.* **A. M. Greene.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 1695–1707, June, 1907.)—The table and curves showing values of C_p at different temperatures and pressures are reproduced from Knoblauch and Jakob [Abstract No. 853 (1907)], and from these, with Peabody's tables for saturated steam, the author shows the method of constructing constant-pressure lines for the temperature entropy diagram, and also the various steps in integral calculation involved. Tables are added for values of C_p at different temperatures of superheat in ten thousandths of a heat unit per lb. per degree per degree; values of entropy from saturation point to temperature T_s in units of entropy per lb. or per kg.; heat in B.Th.U. per lb. from saturation to temperature T_s; and a diagram of lines of entropy for saturated and superheated steam. The original paper should be consulted for these. F. J. R.

746. *Efficiency in Steam-boiler Practice.* **P. Cooke.** (Cassier, 32. pp. 47–65, May, and pp. 106–122, June, 1907.)—Efficiency is dealt with from the economic or commercial standpoint, and the paper is a review of well-known devices for the most efficient treatment of fuel, water, and heat transmission according to modern ideas and practice. Many illustrations of apparatus and of well-known boilers are given throughout the pages. F. J. R.

747. *Steam Traps.* **G. Stewart.** (Mech. Eng. 19. pp. 825–827, June 15, 1907. Abstract of paper read before the Civil and Mech. Engin. Soc.)

748. *Steam as Motive Power for Public Service Vehicles.* **T. Clarkson.** (Inst. Mech. Engin., Proc. 4. pp. 753–787; Discussion and Communications, pp. 787–860, Oct.–Dec., 1906. Engineering, 82. pp. 707, 709–714; Discussion, pp. 688–692, Nov. 23; 753–757, Dec. 7, and pp. 822–826, Dec. 21, 1906.)—The latest type of Clarkson's steam omnibus is fully described, and the results obtained in commercial running are referred to. Numerous theoretical and practical points are discussed. The original should be consulted; no satisfactory short abstract is possible. L. H. W.

749. *Motor-car Traffic on Railways.* **T. H. Riches** and **S. B. Haslam.** (Inst. Mech. Engin., Proc. 4. pp. 651–678; Discussion and Communications, pp. 678–718, Oct.–Dec., 1906. Abstracts in Mech. Eng. 18. pp. 260–264, Aug. 25, and pp. 289–293, Sept. 1, 1906. Engineering, 82. pp. 264–272, Aug. 24, 1906.)—Descriptions and illustrations of the motor coaches in use are given, including some electrical ones. Electrical considerations are, however, but lightly touched upon. L. H. W.

750. *Ball Bearings.* **H. Hess.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 1786–1825; Appendix, pp. 1826–1871, June, 1907.)—The author discusses the use of ball bearings with particular reference to their employment on automobiles. The different types which are best adapted for certain special forms of shaft and axle are considered. The Appendix consists of a translation in full of Stribeck's well-known monograph, which is thus made accessible to those who cannot follow the original. L. H. W.

751. *Note on Suction Producer Plant.* **A. E. Porte.** (Inst. Elect. Engin., Journ. 38. pp. 607–622; Discussion, pp. 622–625, June, 1907. Paper read before the Dublin Section. Electrician, 58. pp. 565–567, Jan. 25; Discussion, p. 691, Feb. 15, 1907. Abstract.)

INDUSTRIAL ELECTRO-CHEMISTRY, GENERAL ELECTRICAL ENGINEERING, AND PROPERTIES AND TREATMENT OF MATERIALS.

752. *Jungner's Carbon Cell.* (Brit. Pat. 15,727 of 1906. Centralblatt Accumulatoren, 8. pp. 53–54, April 5, 1907.)—Carbon burns in sulphuric acid of more than 50 per cent., which, to improve its conductivity, should be heated. In H_2SO_4 of 95 per cent. carbon is electrically almost as active at 95 or 100° C. as zinc is in diluted H_2SO_4. The acid is decomposed, the products being CO, H_2, SO_2, and depolarisers are required in such carbon cells. E. W. Jungner combines an anode of amorphous carbon with a kathode of graphite, depolarised by air or in other ways. The kathode is a perforated tube made of graphite powder and sodium silicate, which is afterwards rendered insoluble, by dipping the mass in magnesium salts, and compressed; powdered glass may also be fused with graphite. The anode consists of pieces of coke, covered by a heavy perforated horizontal anode plate. The cell box stands within another cell box, the space between the two being charged with steam; the outer box is packed with heat-insulating material. Air is forced through the kathodes. The electrolyte, concentrated sulphuric acid, may be charged with NO, N_2O_3, NO_2, oxygen compounds of chlorine, or sulphates of metals which form several sulphates; then a diaphragm of bricked graphite or asbestos is applied. The working e.m.f. is 0·5 volt. Several arrangements are proposed.
H. B.

753. *Extraction of Silicon-free and Silicon-poor Metals, and Silicides from Ores.* J. Weckbecker. (Metallurgie, 4. pp. 317–319, May 22, 1907. Communication from the Inst. f. Metallhüttenwesen u. Elektro-Metallurgie in d. Kgl. Techn. Hochschule, Aachen.)—The author gives a method of extracting, after ferromanganese, a manganese silicide almost free from iron, from manganese ores containing iron. The ore is melted in the electric furnace with a suitable reducing agent in no greater amount than is necessary for the reduction of the iron oxide and a part of the Mn. The rest of the Mn mixed with a trace of iron is slagged off. The slag is separately treated in another electric furnace, together with SiO_2 and coke or other source of C. The ores of Cr, W, Cu-Ni, and Cu-Co may be treated in a similar manner. F. R.

754. *Electroplating Aluminium.* (Mech. Eng. 19. pp. 812–813, June 8, 1907. From "The Brass World.")—In F. S. Loeb's process, after removal of grease, the aluminium is prepared for plating by immersion first in a 5 per cent. hydrofluoric acid solution until gas is freely evolved, then for a few sec. till completely covered with a thin film of mercury, in a "blue dip" made by dissolving 2 oz. cyanide and ⅛ oz. nitrate of mercury in 1 gall. of water, after which it is returned to the hydrofluoric acid solution till gas once more starts from its surface. The Al is then ready for plating with Cu or Ag in the usual manner, and must be first coated with one of these metals, even if nickel-plating is required (as Hg and Ni do not amalgamate well), the Ni being deposited directly upon the Cu or Ag. For copper-plating the use of the following solution, at 150–180° F. is recommended: 2½ oz. copper acetate

is made into a paste with a small quantity of water, to which are then added successively 2½ oz. sodium carbonate dissolved in 1 pint of water, 2½ oz. sodium bisulphite dissolved in 1 pint of water, and 2 oz. potassium cyanide dissolved in 2 pints of water, the whole being then made up to 1 gall.

W. H. Si.

755. *Galvanic Deposits on Aluminium.* (French Pat. 324,981. Rev. Électrique, 7. p. 348, June 15, 1907. Abstract.)—In order to obtain well-adhering metallic deposits on aluminium, J. L. Baille first covers the Al electrolytically with thin layers of copper and of zinc; the metal is then heated so as to form a surface of brass on the Al. The metal can afterwards be further coated with gold, nickel, &c.; it can also be welded, and the superficial layer of brass renders it stronger.

H. B.

756. *Electrolytic Corrosion of Iron and Steel in Concrete.* **A. A. Knudson.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 133–148, Feb., 1907. Abstracts in Electrician, 59. pp. 213–214, May 24, 1907. Mech. Eng. 19. pp. 763–765, June 1, 1907.)—From experiments, as well as observations in practice, the author draws the following conclusions: (1) If but a small fraction of an amp. passes from an interior metallic column or structure into concrete or masonry as usually made, there will be corrosion of the metal and disintegration of the concrete or masonry. (2) Structures of steel in concrete that are subject to sea-water are in more danger from electrolytic action than those in fresh-water, by reason of the lower resistance of concrete in sea-water as shown by the experiments. (3) In no sense can concrete be considered an insulator; it is just as good an electrolyte as any of the soils found in the earth.

L. H. W.

757. *Electrolysis of Gas- and Water-pipes.* (Amer. Inst. Elect. Engin., Proc. 26. pp. 560–598, April, 1907. Discussion and Communications.) [For the papers by Hayden, Rhodes, and Knudson, see Abstracts Nos. 411, 509 (1907), and preceding Abstract.]—**P. Winsor** described the state of affairs in Boston, and stated that when electrolysis is reported a negative feeder is put in or a connection made to the rail. The Water and Sewage Board has certain cast-iron pipes, 4 ft. in diam., and these were protected, after conference with the electrical authorities, by eleven insulating joints. Some of the joints are of rubber, some of wood (ordinary ball and spigot joints), with ⅝ to ¾ in. of pine caulking. A portion of the line was also experimentally operated on the three-wire system, and this was illustrated by a series of elaborate diagrams by **J. W. Corning.** The difficulties of working on this system are recognised, but it had the effect of reducing the fall in the return conductors by 80 or 90 per cent. **A. F. Ganz** said that alternate-current electrolysis is probably due to the fact that the product of the current during the positive half-cycle diffuses away, so that the negative half does not quite reverse the action. Since these rates of diffusion vary with different materials, the result produced depends on the electrolyte. On this theory the effect of increasing the frequency would be to diminish the electrolysis, and this has generally been found to be the case. **C. P. Steinmetz** said the chief underground sufferers were the lead coverings on the telephone cables, which were generally protected by being connected to the negative terminal. But with alternating current it is said that even the small amount of ½ per cent. of the amount due to continuous current would be fatal to telephone cables in a short time. It is

useless to reckon on low current densities, as a cable may be well protected throughout most of its length, and may leak to the ground at isolated places where moisture collects. The corrosion of iron embedded in concrete may be due to the formation of oxides which occupy a larger volume and crack it by irresistible force of expansion, or it may be an electrolytic effect, due to free chlorine, for instance. **F. A. C. Perrine** said that the effects described by Knudson are to some extent well known, and it is quite certain from his experience, instances of which are given, that the passage of current through concrete softens it. It may be indirectly a temperature effect. **H. W. Fisher** and **R. A. L. Snyder** also gave particulars of electrolytic effects with which they have had to deal, the latter of whom had dealt with the problem from the point of view of the telephone engineer. W. H. S.

758. *Electrical Method of extracting Soot from Air in Flues.* **G. W. Walker.** (Nature, 75. p. 606, April 25, 1907.)—The author had some time ago observed that a body positively electrified (100 volts) became covered with soot in a day, while a negatively charged body remained comparatively clean. A method of cleaning air has been evolved from this by Black. A sheet of wire gauze connected to the positive of a 250-volt supply main is inserted in the air-flue. The method is of value for cleaning the air supplied to large buildings in smoke-ridden towns. L. H. W.

759. *Improvements in Meters of the Ferraris Type.* (Elektrotechnik u. Maschinenbau, 25. pp. 429–430, June 2, 1907.)—If M, S, and B denote respectively the fields of the main coil, the shunt coil, and the braking magnet, the "constant" C of the meter $\left(C = \frac{\text{watts}}{\text{revs./sec.}}\right)$ is proportional to $V/S(B^2 + S^2 + M^2)$, where V is the voltage. In order to render C practically independent of the load, M is made as small as possible in comparison with B and S. In that case, we may write $C \propto (V/S)(B^2 + S^2)$, and, if $S \propto V$, $C \propto B^2 + S^2$. Since S changes with voltage and frequency (in opposite directions), C will be affected by variations of voltage or frequency. In order to compensate such variations, O. T. Bláthy proposes to design the shunt magnet so that S is no longer proportional to V, but that $(V/S)(B^2 + S^2)$ becomes approximately constant [D.R.-P. 174,392]. This may be effected by dividing the total flux due to the shunt coil into two portions, one of which is effective in producing torque, while the other is inoperative and contains a core provided with a constriction which is saturated even at low loads; or the shunt coil may be connected in series with a reactance coil provided with a suitably constricted core. Another method patented by the same inventor consists in making use of a movable coil for obtaining the desired relation between the current and the flux due to it [D.R.-P. 176,345]. A. H.

760. *New Type of Recording Instrument.* **H. W. Young.** (Elect. Rev., N.Y. 50. pp. 886–889, June 1, 1907.)—The new type of recording instrument described by the author is being manufactured by the Westinghouse Co. Its main features are the use of a relay to control the solenoids which operate the recording pen, the use of rectilinear co-ordinates on the recording paper, the pen moving across the paper in a straight line instead of in a circular arc as in the ordinary form of recording instrument, and an electrically-wound pendulum clock for driving the paper roll. The measuring part of the instrument consists of an electrodynamo-

meter of the Kelvin balance type. Attached to the end of the balance beam is the tongue of a relay, moving between two stops. When contact is made with either stop, one or other of a pair of solenoids actuating a see-saw lever is energised. The see-saw lever, which is placed below the balance beam, is connected to this latter by a spiral spring, and the electrodynamic couple acting on the beam is balanced by the tension of this spring. Projecting upwards from the see-saw lever is an arm (the whole forming a ⊥), pivoted to the end of which is the middle of the recording pen, the upper end of the pen being slotted and moving past and around a fixed guide-pin—a rectilinear motion of the pen being thereby obtained. The cores suspended from the ends of the see-saw lever are provided with oil dash-pots. A. H.

761. *Theory of Electric Meters.* **A. Rossi.** (Assoc. Ing. Él. Liége, Bull. 6. pp. 82–88, Jan., 1907.)—Let w denote the energy expended on the installation during the time T, and let p be the instantaneous power, then $w = \int_0^T p\,dt$. Also, if ω be the angular velocity of the rotating part and a the angle turned through, we have $a = \int_0^T \omega\,dt$. Now in an electric meter we must have $\omega = \mathrm{R}a$, and hence $p = \mathrm{R}\omega$, where R is the constant of the instrument. In a meter, therefore, the angular velocity of the rotor must always be exactly proportional to the power being expended. In actual meters this condition is only fulfilled approximately. If Mk^2 be the moment of inertia of the rotor, the equation of motion will be—

$$Mk^2 . d\omega/dt = ap - b\omega,$$

where a and b are constants, and p and ω are functions of the time. Integrating this equation from the time t_1 to the time t_2, we have—

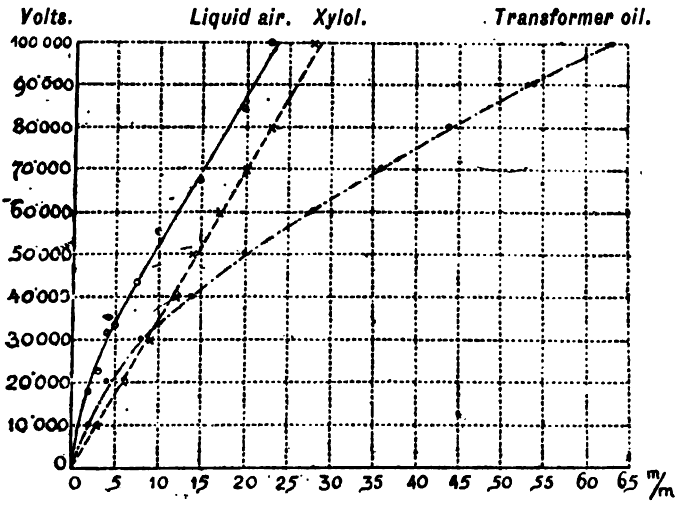
$$Mk^2(\omega_2 - \omega_1) = aw - b(a_2 - a_1).$$

Hence $a_2 - a_1$ is only directly proportional to w when $\omega_2 = \omega_1$. It reads correctly, for instance, from the starting to the stopping of the instrument. The author finally considers the theory of the single-phase alternating-current Batault meter. A. R.

762. *Measurement of Magnetic Induction in Fields of* 100 *to* 1,000 *Gauss.* **H. Armagnat.** (Rev. Électrique, 7. pp. 113–118, Feb. 28, 1907.)—Describes a method of measuring the induction with a straight bar of iron by means of a ballistic galvanometer, the current through the coil surrounding the bar being reversed. A correction is made for the demagnetising effect of the ends of the bar. The permeameter of Carpentier for high inductions, which is on this principle, is then described. It consists of a magnetising coil in series with the primaries of two air-core transformers. There are two coils wound in the centre of the magnetising coil, either of which can be connected to the ballistic galvanometer, and each is respectively in series with one of the secondaries of the air transformers, but connected so that the e.m.f.'s induced in each oppose one another; by means of a two-way switch either can be connected to the galvanometer. The coefficients of mutual induction of the air transformers are such that direct readings of H and B are given in the ballistic galvanometer when the magnetising current is reversed. E. C. R.

763. *Instrument Control Springs.* **C. C. Garrard.** (Elect. Engin. **39.** pp. 750–751, May 31, and pp. 799–801, June 7, 1907.)—The author arrives, by the usual analysis for a plane spiral spring, and taking the maximum safe stress in phosphor-bronze spring strip as 6×10^5 c.g.s., at the formulæ $\omega = 12 \times 10^5 L/Et$, and $b = 12CL/\omega t^3 E$, where L = length of spring, E = Young's modulus, ω = max. deflection, b = width and t = thickness of metal, and C is the couple winding the spring. These are plotted conveniently for design. Two forms of apparatus are described, one for testing the torque of a spring against the moment of a weight on a pivoted lever, the other for maintaining a spring loaded to its maximum deflection for a considerable time in order to note the creep of zero, if any, due to time strain of the stressed metal. Springs are conveniently compared by noting the periodicity of oscillation when mounted as in a watch balance. F. R.

764. *Dielectric Rigidity of Liquid Air.* **E. Jona.** (Atti dell' Assoc. Elettr. Ital. **11.** pp. 47–52, Jan.–Feb., 1907.)—The author gives the following diagram for sparking distances and corresponding voltages in liquid air, xylol, and transformer oil. Liquid air does not, however, seem suited for high insula-



tion purposes, in spite of its reducing the resistance of conductors; its low temperature does not improve the magnetic properties of iron so as to reduce the heat produced by more than 2½ to 5 per cent. A large supply of liquid air would therefore be required. Compressed air seems practically more hopeful, unless high tensions were found to produce ozone and nitrous compounds in it, which destroy any insulating material of organic origin. A. D.

765. *Effect of Pressure on Dielectric Strength of Gases.* **W. Voege.** (Elektrotechn. Zeitschr. **28.** pp. 578–581, June 6, 1907.)—It is well known that the dielectric strength of gases increases with the pressure, and for short spark-lengths Paschen has established the law that the sparking voltage remains the same so long as the product of spark-length and pressure is maintained constant. The author undertook a series of experiments with

the object of ascertaining whether Paschen's law also applied to greater spark-lengths of from 10 to 80 cm. The gas to be experimented on was contained in a strong glass vessel fitted with glass stoppers at the sides, the pointed platinum sparking electrodes passing through the axes of the stoppers and being fused to them. The sparking voltage was measured by the spark-length in air at ordinary pressure. A transformer capable of giving an amplitude of up to 170,000 volts was used as the source of e.m.f., the primary being supplied with a pure sine wave of p.d. at a frequency of 50. The gases experimented on were air, carbon dioxide, oxygen, and hydrogen. Paschen's law was found to hold good. The curves connecting the sparking voltage with the product of pressure into spark-length for air and CO_2 were found to intersect, and this result is explained by the author as due to the reaction on the anode of the negative ions sent out by the kathode. A. H.

766. *Oscillograms of Non-periodic Phenomena.* **J. T. Morris.** (Electrician, 59. pp. 292–294, June 7, 1907.)—The oscillogram of the non-periodic phenomenon under investigation was obtained by the use of a falling photographic plate. The earlier part of the paper deals with the behaviour of various forms of switch contact. Many of these were found to momentarily break the circuit immediately on making it, owing to mechanical recoil. The switch to be investigated was arranged to be released by the cutting of a thread stretched across the path of the falling photographic plate. After trying various arrangements, the author found a suitably modified knife-blade contact to give satisfactory results. The modification consisted in providing the contact blade with an ebonite extension piece on its lower surface which fitted between the (extra long) contact-clips when the switch was in the "off" position. On closing the switch, the metal portion of the blade then glided into smooth contact with the clips without causing any vibration such as would ordinarily take place owing to the clips being suddenly pushed apart at the instant of closing the switch. Using this form of contact, the author obtained a series of oscillograms showing the growth of a current in an inductive circuit, the charging current of a condenser, the oscillatory discharge of a condenser, the starting current of an "osram" lamp, the current through a fuse at the time of its "blowing," and the current rush on connecting a transformer to alternating-current mains. A. H.

767. *Method of compensating Skin Effect in Cables.* **F. Dolezalek** and **H. G. Möller.** (Ann. d. Physik, 22. 3. pp. 559–568, March 5, 1907. Phys.-chem. Inst. d. Univ., Göttingen.)—The method proposed by the authors consists in connecting in series with the various layers surrounding the central conductor suitable reactance coils, thereby equalising the total reactances of the different layers, and so constraining the current to become uniformly distributed over the cross-section of the cable. Some experiments carried out with high-frequency (625 $\sim$) currents show the feasibility of the plan. The compensation holds good for all frequencies. A. H.

768. *Voltage Drop in Alternate-current Cables.* **E. Stirnimann.** (Elektrotechn. Zeitschr. 28. pp. 581–584, June 6, and pp. 607–610, June 13, 1907.)—Numerous measurements carried out by the author on cables of large cross-section conveying alternating currents have shown that the drop along such cables, and the loss of power taking place in them, greatly exceeded the values which could be accounted for by the skin effect or by eddy currents

in the sheathing. A careful study of this effect has led the author to offer the following explanation. Consider two points, A and B, in one of the outer strands of a large cable, so situated that between A and B the spiral path of the strand completes a whole turn. Two paths are open to the current from A to B, one being a path of high resistance, from strand to strand, along the straight line joining A and B, and the other being the spiral path of the strand, which, although of low resistance, possesses appreciable reactance, owing to the spirality of the strand and of the other strands in the same layer. It is by reason of the axial component of the magnetic field due to the spirality of the strands, and the reactance corresponding to it, that there results a greatly increased drop along a cable of large cross-section. The remedy adopted against this difficulty in the case of a 400 sq. mm. cable consisted in constructing the cable of a number of smaller cables lightly insulated from each other, the component cables being twisted up like the simple strands of an ordinary cable. By the great reduction of spirality and of the longitudinal field caused by it, the drop was thus reduced from 2·62 to only 1·02 times the continuous-current drop. The form of construction just mentioned had, the author found, been previously patented by the Société d'Exploitation des cables électriques système Berthoud and Borel, of Cortaillod, but had not been made use of. This the author attributes to probable ignorance, on the part of most engineers, of the magnitude of the effect under discussion. He is of opinion that all cables for alternating currents above 100 sq. mm. in cross-section should be of the special type of construction described above. A. H.

769. *Relays for the Control of High-tension Switchgear.* C. C. Garrard. (Elect. Engin. 39. pp. 570–578, April 26, 1907. Electrical World, 49. pp. 1116–1117, June 1, 1907.)—Best practice in the control of the automatic switchgear on high-tension systems has become standardised as follows: As circuit-breaking apparatus the totally enclosed oil-break switch is used. If this be automatic in action, in but few cases can it be controlled by a simple solenoid with an instantaneous release. In by far the majority of cases a relay is used for controlling the circuit breaker. When the circuit controlled feeds bus-bars, a reverse-power relay must be installed. If the circuit takes current from the bars, inverse time-element, maximum-current relays are necessary. These latter must be capable of adjustment both as regards time element and operating current. The reverse-power relay should also have a certain time element. The object of the article is to discuss several points which have shown themselves to be of importance in a somewhat extensive experience with such apparatus. The article goes on to discuss many interesting points in the different relay systems. W. J. C.

770. *Metallic Hose Resistances.* (Elect. Engineering, 1. pp. 984–985, May 30, 1907.)—Reproduces in full the specification of Brit. Pat. 27,984 of 1906, of R. v. Brockdorff, which describes the use of flexible metallic tubing for the purpose of resistances for large currents. The resistance of such a steel hose of 8 mm. internal diam. and of weight 180 gm. per m. is 38·8 times that of a steel tube of the same length and weight. When water-cooled with a flow of 10 litres per min., such a hose 1 m. long can take 400 amps. at 125 volts. With eight 1-m. lengths of such hose in parallel such a resistance can take charge of 400 kw. if cooling water at the rate of 80 litres per min. is supplied. The use of hose of some special high-resistance material is also mentioned. L. H. W.

771. *Flexibles and the testing of Rubber.* **A. Schwartz.** (Inst. Elect. Engin., Journ. 39. pp. 31–100; Discussion, pp. 101–119, July, 1907. Abstracts in Electrician, 59. pp. 11–14, April 19; 53–55, April 26; 95–97; Discussion, pp. 97–98, May 3; and pp. 144–145, May 10, 1907. Elect. Engineering, 1. pp. 719–722, April 25; 763–767, May 2; 793–796, May 9; Discussion and Communications, pp. 841–844, May 16, 1907.)—The first part of this paper is devoted to a detailed study of the conductors and insulation of flexibles. The question of mechanical strength, the effect of temperature on the tenacity of copper, the temperatures attained in lampholders, the effects of sulphur, tin, and chemical fumes on the conductors, the temperature-rise and kindling points of flexibles insulated with pure and vulcanised rubber, and the insulation of flexibles, are dealt with in succession. The author, on the whole, favours the use of pure rubber as against vulcanised flexibles, and this opinion is shared by those taking part in the discussion. The second part of the paper is devoted to the properties of rubber, and the investigation of various methods of testing having for their object the discrimination of good rubber from bad. The author believes that a mechanical test, consisting in the determination of the extension and subsequent contraction as the load is first increased to a maximum and then decreased, would be of considerable value, although a different view is expressed by some of the speakers in the discussion. Numerous other points are dealt with, such as chemical and electrical tests, the testing of finished flexibles, thickness of insulation, and flexible wiring systems. In a series of appendices are given the American, French, and German regulations relating to flexibles. A. H.

772. *Cutting Steel Piles by means of the Electric Arc.* (Electrical World, 48. pp. 1055–1056, Dec. 1, 1906. Electrician, 58. p. 486, Jan. 11, 1907.)—The steel piling used for foundations at the Hoffman House, New York, was cut off level by means of the arc. A carbon electrode is pushed against the iron, thus forming the arc, which must not be broken when once started. The arc took 650 amps. at 50 volts (best voltage) alternating. In a day of 8 hours 10 ft. of piling can be cut through, taking 256 kw.-hours. The cost (energy at 10 cents per kw.-hour and including $4 per day for attendant) is given as $3.00 per foot cut, as against $13.40 per foot by drilling. L. H. W.

773. *Driving of Wood-working Machines by Electricity.* (Engineer, 103. pp. 569–572, June 7, 1907.)—The advantages of this form of motive power for wood machinery are summarised as follows: (1) Economy of power owing to the exact current required being taken at each moment. (2) Simplicity in driving. (3) The saving effected in initial cost of shafting, belting, &c., and in repairs. (4) A great economy of space. (5) The absence of heavy driving belts. (6) Facilities in arranging the machines. (7) Facilities for extension. (8) The great advantage obtained by being at once able to check the power taken by any individual machine. Tables are given of the h.p. required for the effective working of different kinds of wood machinery. W. J. C.

REFERENCE.

774. *Utilisation of Atmospheric Nitrogen for Industrial Purposes.* **P. F. Frankland.** (Soc. Chem. Ind., Journ. 26. pp. 175–179; Discussion, pp. 179–180, March 15, 1907.)—The chief feature of this *résumé* is the reproduction of two patent specifications dealing with the arc process of the Badische Anilin-und Sodafabrik [see Abstract No. 517 (1907)].

GENERATORS, MOTORS, AND TRANSFORMERS.

775. *Alternator Design as affected by Rated Speed.* **H. M. Hobart** and **A. G. Ellis.** (Elect. Engineering, 1. pp. 755–759, May 2; 881–886, May 16; and pp. 919–922, May 30, 1907.)—In order to investigate the effect of speed and output on the design of alternators, the authors have worked out designs for various speeds of a 400-kv.a., 3,000-volt and 550-volt, 50-cycle, 3-phase alternator; and a 3,000-kv.a., 11,000-volt machine of the same type; also three designs for a 6,000-kv.a., 750-r.p.m. alternator at three different frequencies; and three designs for 750-r.p.m., 8-pole alternators of different outputs. A study of the various designs shows that there is a certain speed for a given rated output and frequency which results in the most economical design. The value of this speed depends on the number of poles corresponding to the given frequency, as it is found that the characteristics of the machine depend on the number of poles rather than on the speed *per se.* In general, designs for rated outputs up to 2,000–3,000 kv.a. are most favourable and economical when the design has a speed corresponding to 4 poles. For rated outputs higher than 3,000 kv.a., the most favourable speed corresponds to 6 or 8 poles. Two-pole designs are condemned by the authors; owing to the high centrifugal stresses, the design of the rotor presents difficulties, and its construction is expensive; the balancing difficulties are great, the regulation poor, and there is no saving of material in comparison with 4-pole machines. Where a 2-pole design has been decided upon, it would appear better to use a rotating armature rather than a rotating field, owing to the better regulation and smaller total weight. A. H.

776. 2,000-*kw. Willans-Dick Kerr Turbo-alternators.* (Electrician, 59. pp. 300–302, June 7, 1907. Elect. Engin. 39. pp. 786–790, June 7, 1907. Elect. Rev. 60. pp. 927–929, June 7, 1907.)—A description is given of the 2,000-kw. turbo-generators which are being supplied to the Sydney (N.S.W.) Municipality. The turbine is of the standard Willans pattern; the high-pressure end of the rotor is used as a balancing piston. The turbine casing is built up in three sections. The blading is of the shroud-ring type. The turbine is capable of standing a 20 per cent. overload for 2 hours. The normal working boiler pressure is 150 lbs. per sq. in., and the steam is superheated 85° to 145° F.; the normal speed is 1,500 r.p.m. The alternator has an output of 2,000 kw. at a power-factor of 0·85, voltage of 5,200, and frequency of 50. The 4-pole rotor is of the radial pole type; its body consists of a central solid steel casting cast under pressure; the pole-tips are laminated and dovetailed into the poles. The edge-strip field winding, after being formed and insulated, is subjected to hydraulic pressure in an axial direction about 50 per cent. in excess of the pressure due to centrifugal stress. Between the field coils special gunmetal wedges are provided to support the coils against the distorting effect of centrifugal stress. The collector rings are of special cast iron, and are shrunk on over micanite rings. The brushes are of a high-conductivity graphite having a low coefficient of friction. A special feature of the stator are the strong brackets provided for supporting the coil ends. The steam consumption at full load was found to be rather less than 15·5 lbs. per kw.-hour. A. H.

777. *Heating of Commutators.* **A. Müller.** (Schweiz. Elektrot. Zeit. 4. pp. 241–248, May 25, and p. 255, June 1, 1907.)—After a detailed discussion of the losses taking place in commutators, the author arrives at an extremely simple formula for ascertaining whether the cooling surface is sufficient to prevent an excessive rise of temperature. Assuming the maximum temperature-rise to be 40° C., the cooling surface S, expressed in sq. cm., should be such that S is not less than kI, where I is the full-load current of the machine in amps., and k a coefficient whose value ranges from 4 to 6 for carbon brushes, and from 1·1 to 1·7 for copper brushes. When designing a new type of machine it is advisable to use the higher values of k in order to be on the safe side. A. H.

778. *The Theory of Commutation.* **A. Liénard.** (Écl. Électr. 51. pp. 861–867, June 15, 1907.)—For good commutation we must have R_1T greater than L, where T is the duration of the commutation, L the self-inductance, and R_1 the resistance of the short-circuited coil. This condition was first given by Girault [Abstract No. 1898 (1898)]. It is obtained on the assumption that the breadth of a brush is exactly equal to that of a commutator bar. The author discusses fully several particular cases, and states that his method can be easily extended to the case of a brush covering any number of commutator bars. For instance, for the case of three bars we have—

$$R_1T > \begin{vmatrix} L & M & M' \\ M & L & M \\ M' & M & L \end{vmatrix} \div \begin{vmatrix} L & M \\ M & L \end{vmatrix}$$

$$> \frac{L^2 - M^2}{L} - \frac{(M^2 - M'L)^2}{L(L^2 - M^2)}.$$

M′ is the mutual induction between the two extreme coils covered by the brush. If this be true, then the currents in the short-circuited coils will have finite values, and so commutation will be possible. In order to solve the problem completely it is necessary to know the maximum value of the short-circuit current, but it is very difficult to obtain a working formula for this current. A. R.

779. *Utilisation of Equalising Currents between Brushes of Same Polarity.* (Brit. Pat. 19,717 of 1906. Engineering, 83. p. 697, May 24, 1907. Abstract.)—The Felten and Guilleaume-Lahmeyerwerke propose to utilise the equalising

Fig. 1.

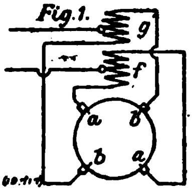
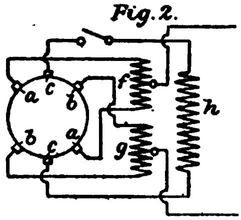


Fig. 2.



currents which are, as a rule, found to circulate between brushes of the same polarity for the purpose of exciting, or varying the excitation of, or compensating an alternating-current commutator motor. In Fig. 1 is shown one method of doing this in the case of a four-pole motor, the windings f and g being non-inductive towards the working current, which enters and leaves at their middle points. Fig. 2 shows an arrangement in which the windings f and g traversed by the equalising currents form the primaries of a trans-

former, whose secondary *h* supplies a compensating current through the auxiliary brushes *cc*. A. H.

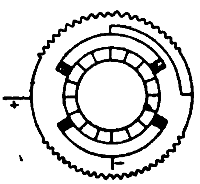
780. *New Stroboscopic Method of Measuring Slip of Induction Motors.* **H. Schultze.** (Elektrotechn. Zeitschr. 28. pp. 557–559, May 30, 1907. Communication from the Physikal.-Techn. Reichsanstalt. Ind. Élect. 16. pp. 295–296, July 10, 1907. Electrical World, 50. pp. 52–53, July 6, 1907.) —The method described by the author depends on the electrical production of capillary waves on the surface of a liquid of high dielectric constant. A shallow cylindrical glass vessel, about 20 cm. in diam. and 10 cm. high, is provided with two electrodes, one of which consists of a continuous coating of pure tin-foil applied to the inner cylindrical surface, while the other is a Pt wire arranged to dip into the liquid at the centre. It is found that if a suitable alternating p.d. is applied to the two electrodes, a system of annular waves is produced which travel from the centre outwards. The production of these waves is due to the tendency of the tubes of electrostatic induction to crowd into a medium of high dielectric constant, the liquid in the immediate neighbourhood of the platinum electrode, where the field is very intense, rising up the electrode as the voltage increases and then falling back again as it decreases to zero. For lower voltages, distilled water is a suitable liquid, and the best results are obtained with a p.d. of about 500 volts; in the case of higher voltages it is advisable to introduce a water resistance so as to cut down the p.d. across the electrodes to 500 volts. For much higher p.d.'s, oil of turpentine may be used, and with this the best results are obtained at 5,000–8,000 volts. The vessel having been placed on a white porcelain plate, and the electrodes connected to the supply mains, the surface of the liquid is strongly illuminated by flashes of a parallel beam of light which falls on it in an oblique direction, the beam being produced by a Nernst lamp placed at the focus of a condenser; the light, after passing through the condenser, is intercepted by a stroboscopic disc (mounted on the motor shaft) which contains as many narrow radial slits as there are poles in the motor, so that the liquid is momentarily illuminated by flashes whose frequency is equal to that of the capillary waves. By counting the number of waves which pass a given fixed point per sec., we obtain twice the slip frequency. Slips up to 4 per cent. at a frequency of 50 may thus be measured. A modification of the method is described which enables the range of the method to be extended up to 8 per cent. A. H.

781. *Starting Device for Induction Motors.* (Mech. Eng. 19. p. 817, June 8, 1907.)—The device described has been patented by the British Thomson-Houston Co., Ltd. It is specially applicable to single-phase induction motors, such as fan motors, which are provided with reactance coils for purposes of speed regulation. In such cases the speed-controlling switch is sometimes placed in an inaccessible position, while an ordinary snap switch is employed for starting or stopping the motor. If the entire reactance is left in series with the motor, the starting torque may be insufficient to overcome the friction of the rotor. The device in question is a centrifugal switch which short-circuits the speed-regulating reactance when the motor is at rest, and automatically open-circuits it above a certain speed. A. H.

782. *Resistance Connectors.* (Brit. Pat. 21,282 of 1906. Engineering, 83. p. 730, May 31, 1907. Abstract.)—Siemens Bros. Dynamo Works, Ltd., and

F. Lydall have patented a special type of construction for the resistance connectors of single-phase commutator motors. The construction described is fire-proof, so that the connectors are capable of withstanding very heavy overloads. It consists essentially of sheet-metal stampings of high resistivity, insulated from each other by sheets of mica, and sandwiched in between thin copper plates, each of which is provided with a lug, the lugs of the consecutive plates being connected alternately to the commutator and the armature conductors. A. H.

783. *Combined Series and Compensated Repulsion Motor.* E. Danielson. (Elektrotechn. Zeitschr. 28. pp. 550–553, May 30, 1907.)—The general arrangement of the motor described by the author is shown in the Fig. Latour's arrangement of short-circuited brushes [Abstract No. 104 (1905)] is used. The stator is only partially wound, the winding covering that portion of the core which is directly opposite the short-circuited portion of the rotor winding. With the connections arranged as shown, the motor is a compensated repulsion motor. By disconnecting a pair of diametrically opposite brushes, it is converted into a plain series motor, and if the rotor ampere-turns be made equal to those of the stator, the resultant field will have a zero value at the active brushes, and good commutation will be obtained. The behaviour of this type of motor is investigated by the author, and its advantages are summed up as follows. It combines the good features of the compensated repulsion motor in the neighbourhood of synchronous speed with those of the series motor at hypersynchronous speeds, and is characterised by a high power-factor. In all cases where it is desired to make use of a compensated repulsion motor, the type under consideration may also at any time be converted into a continuous-current series motor—a problem which had not previously been solved. Lastly, although the motor is capable of running as a compensated repulsion, a single-phase series, and a continuous-current series motor, it contains only a single stator winding, and is of simple mechanical construction, allowing of a division of the stator into two sections hinged together—an arrangement which is not possible with every type of single-phase motor.



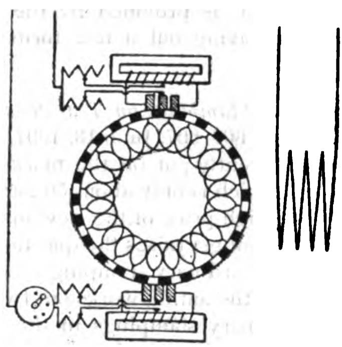
A. H.

784. *Starting Device for a Repulsion-Induction Motor.* (Electrical World, 49. p. 1061, June 1, 1907.)—The device described, which is intended for use with a motor of the Wagner type, consists of an auto-transformer of special construction, which enables the voltage to be varied in such a manner as to maintain the torque practically constant from standstill to normal speed. The auto-transformer has its last few sections reversed, the connections being so arranged that as the starting switch is gradually moved over the various contacts the voltage is first steadily raised until it reaches a value greater than the normal, and is then reduced to its normal value. This method of raising the voltage above its normal value and then reducing it is broadly claimed by the patentee, W. A. Layman (U.S. Pat. 851,890). A. H.

785. *Prevention of Sparking in Compensated Single-phase Commutator Motors.* (Brit. Pat. 20,233 of 1906. Engineering, 83. p. 730, May 31, 1907. Abstract.)—The resultant field in compensated single-phase motors is not a simple rotating one, but consists, as a rule, of a rotating field on which is superposed an alternating field. This latter causes sparking at the brushes

short-circuiting coils which are exposed to the inductive influence of the alternating component of the field. The Felten and Guilleaume-Lahmeyer-werke propose to deal with this difficulty by using brushes of exceptionally high resistivity for the set liable to spark, or by reducing the cross-section of the brushes, or by using compound brushes whose component parts are connected through a suitable resistance. A. H.

786. *Prevention of Sparking in Single-phase Commutator Motors.* (Electrical World, 49. p. 1019, May 25, 1907.)—A. S. McAllister has recently patented the arrangement shown in the Fig. Instead of using resistance connectors between the armature and the commutator, he proposes splitting



each brush into three sections, the two outer ones being connected through the winding of an auto-transformer, and the resistances being inserted between the middle brush and the middle point of the auto-transformer winding. The commutator is provided with twice the usual number of segments, alternate segments—shown black in the Fig.—being dead (U.S. Pat. 851,828). A. H.

787. *Heating Tests of Transformers.* **A. F. Gustrin.** (Elektrotechn. Zeitschr. 28. pp. 574–576, June 6, 1907. Écl. Électr. 52. pp. 95–97, July 20, 1907.)—In order to effect a saving of energy during the heating test of a large transformer, various methods have been devised in which the power absorbed by the transformer is no greater than the power wasted in it. In one of these methods the iron losses are supplied by an alternating current, while the copper losses are produced by continuous currents; this method is, however, rather complicated [Abstract No. 2274 (1901)]. In another method the transformer is first run for a time on open circuit with a primary p.d. which is in excess of the normal working p.d. by an amount such that the core loss is equal to the total losses at full load under normal conditions; the transformer is then short-circuited, and the short-circuit currents adjusted so as to make the copper losses equal to the total full-load losses. By alternately using these two arrangements, the transformer is finally brought to a steady temperature. The disadvantage of this method is the necessity of changing over periodically from a higher to a lower voltage, and of applying a primary voltage to the transformer which may be some 50 per cent. in excess of its normal voltage. By far the most convenient method is that in which two similar transformers are used with their secondaries connected in opposition (as in the Sumpner efficiency test), the balance of e.m.f.'s being disturbed in any suitable way (either by means

of a small auxiliary transformer, or by leaving out some of the turns in one of the secondaries), so as to produce the full-load currents in the windings. The author has devised a modification of this method which renders it applicable to single transformers. The method consists in dividing the primary and secondary windings into two unequal sections; the two sections of the primary winding being connected in parallel with each other and so as to oppose each other's magnetic effects, and being supplied at a p.d. which is about half the normal primary p.d.; while the two sections of the secondary are connected in opposition. The method may be easily extended to a single three-phase transformer, by connecting both primary and secondary windings Δ-fashion. The secondary Δ is opened at one corner, and a disturbing e.m.f. is introduced sufficient to give rise to the full-load currents. The disturbing e.m.f. is provided by the secondary of a small auxiliary transformer, or by leaving out a few turns in one phase of the secondary. A. H.

788. *Effect of Alloyed Iron Stampings on Transformer Design.* **R. Pohl.** (Elektrotechn. Zeitschr. 28. pp. 606–607, June 13, 1907.)—Although stampings of the special alloy of iron recently put on the market [Abstracts Nos. 187 and 1298 (1906)] have a loss which is only about 50 per cent. of that obtained with ordinary stampings, the high price of the new material (which is about 2½ times that of ordinary stampings) raises the question as to whether it will be capable of competing with ordinary stampings. In order to investigate this problem in a specific case, the author works out two designs for a 50-kw., 50-∿ transformer, using ordinary stampings in the one case and alloyed ones in the other, and in each case adopting the most economical arrangement of materials. A comparison of the final results shows that the adoption of alloyed stampings results not only in increase of efficiency, but also in reduction of cost of materials and weight. The most economical ratio (*iron weight*)/(*copper weight*) is reduced from 8 to 2, and the most economical thickness of stamping and induction are considerably increased, by the use of the new material. The above advantages can, however, be only realised in the smaller sizes of transformers, but not in large transformers working at high inductions. A. H.

789. *Test of a Mercury Arc Rectifier.* **J. Polak.** (Elektrotechnik u. Maschinenbau, 25. pp. 415–419, June 2, 1907. Écl. Électr. 52. pp. 59–60, July 18, 1907. Elect. Engin. 40. pp. 44–45, July 12, 1907.)—The rectifier tested was of the Weintraub type, constructed by the General Electric Co., and intended to transform 840-volt single-phase current of frequency 50 into continuous current at from 110 to 155 volts; the current capacity was 30 amps. The two positive electrodes were of graphite. Oscillograms are given by the author, showing the p.d. and current waves on both the primary and secondary sides. The efficiency was found to range from about 78 to about 85 per cent. There is a minimum value of the current below which the rectifier is automatically thrown out of action. During the 14 days over which the tests extended the rectifier worked without giving any trouble. A. H.

REFERENCE.

790. *Control of Single-phase Commutator Motors.* (Elect. Engin. 39. pp. 794–795, June 7, 1907.)—V. A. Fynn has patented a method of controlling the speed of neutralised commutator motors which consists in varying by electromagnetic means the relations between the transformer e.m.f. and the rotation e.m.f. of the rotor. Various methods of applying this principle are briefly indicated. A. H.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

791. *Direct-current Compensators for Balancing Electric Circuits.* **H. M. Biebel.** (West. Soc. Engin., Journ. 12. pp. 250–260; Discussion, pp. 260–266, April, 1907.)—A direct-current compensator is a device whereby one or more neutral wires can be introduced into an ordinary two-wire circuit. These neutral wires make it possible to obtain circuits of proportionally lower voltage. The present type of compensator consists of two machines coupled together mechanically, the voltage of each being half that of the generator. The theory of the compensator is explained. The commercial efficiencies of a line of compensator sets from 1-kw. to 150-kw. capacity varies from 78 to 90 per cent. It is recommended that a compensator set be fused for 100 per cent. overload. Circuit breakers or special tripping devices should not be used. When it is desired to operate 110-volt lamps on a 220-volt circuit, and the lamps can be so wired that the loads on each side of the neutral will be approximately the same, a compensator set will prove extremely useful. Its capacity need only be about 10 per cent. of the unbalanced load. A. R.

792. *Alternating-current Transmission on Long Lines.* **A. E. Kennelly.** (Amer. Acad., Proc. 42. No. 27. pp. 701–715, May, 1907.)—The case of a long single wire with earth return is considered. The generator is supposed to have negligible impedance and to be generating a harmonic e.m.f. The author considers the electrostatic and electromagnetic fluxes in the initial state, and finds simple formulæ which enable us to picture what is happening in the unsteady state, and how the steady voltages and currents are built up. The conductor linear resistance, inductance and conductance, are denoted by r, l, g respectively and the capacity per unit length by c. Then if E and I are the initial voltage and current, the steady values of the instantaneous voltage and current at a distance x from the generator are given by—

$$e = \mathrm{E}\cosh x\alpha - \mathrm{I}z_0 \sinh x\alpha,$$
$$i = \mathrm{I}\cosh x\alpha - (\mathrm{E}/z_0)\sinh x\alpha,$$

where—

$$\alpha = [(r + jl\omega)(g + jc\omega)]^{\frac{1}{2}}$$
$$z_0 = [(r + jl\omega)/(g + jc\omega)]^{\frac{1}{2}}, \text{ and } j \text{ stands for } \sqrt{-1}.$$

The author calls α the "attenuation constant" of the circuit. The real part of α is called the real attenuation constant (α_1), and the imaginary part $j\alpha_2$ he calls the wave-length constant. The impedance z_0 is called the "initial sending-end impedance" of the line. When the distant end of the line is earthed through an impedance z_r, the steady value of the current $\mathrm{I_B}$ at this end is given by—

$$\mathrm{I_B} = \mathrm{E}/(z_0 \sinh l\alpha + z_r \cosh l\alpha),$$

where l is the length of the line. If the line had been infinitely long the current i at a distance x from the generating end equals $\mathrm{I}_0\epsilon^{-x\alpha}$. If, however, the circuit be comparatively short and be open at the far end, the initial disturbance will be reflected back. Let us consider the effect of the reflec-

tion on the electrostatic flux. The voltage in the reflected wave starts back with the amplitude and phase with which it strikes the far end. It returns to the generating station attenuating in exactly the same way as on its outward journey. The voltage at the far end was zero until the wave reached it, when it became $E\epsilon^{-la}$, the reflection making it jump immediately to $2E\epsilon^{-la}$. The voltage at the far end would therefore be $2E^{-la_1}\sin(\omega t - a_2)$ at any instant after arrival. By the time the wave-train gets back to the generating station it will have travelled a distance $2l$. The arriving voltage will therefore be $E\epsilon^{-2la}$. The wave will now go direct to earth through the alternator. A voltage wave passing through an earth virtually swings round the goal and returns on its path reversed. The wave thus returns, but with reversed sign. The voltage at the generating station is thus unaffected by the return of the wave. Proceeding in this way we find that the voltage E_B at the far end (B) is given by—

$$\begin{aligned} E_B &= 2E[\epsilon^{-la} - \epsilon^{-3la} + \epsilon^{-5la} - \ldots] \\ &= E/\cosh la, \end{aligned}$$

which agrees with the formula for the steady state found in the usual way. Similarly, for the current I_A at the generating station we have—

$$\begin{aligned} I_A &= I_0 - 2I_0\epsilon^{-2la} + 2I_0\epsilon^{-4la} - \ldots \\ &= E/(z_0 \coth la). \end{aligned}$$

If the line be earthed at B we obtain in a similar way—

$$\begin{aligned} I_B &= 2I_0\epsilon^{-la} + 2I_0\epsilon^{-3la} + 2I_0\epsilon^{-5la} + \ldots \\ &= E/(z_0 \sinh la), \\ \text{and } I_A &= I_0 + 2I_0\epsilon^{-2la} + 2I_0\epsilon^{-4la} + \ldots \\ &= E/(z_0 \tanh la). \end{aligned}$$

Finally, when the line is earthed through an impedance z_r at B, the current $I_0\epsilon^{-la}$ arriving at B with the first pulse from A is partly reflected with inversion as from a discontinuity, and the rest of it passes through the impedance z_r to earth without further reflection. The fraction m of the current that goes through z_r is called the transmission coefficient of the impedance z_r, and is given by—

$$m = 2z_0/(z_0 + z_r).$$

Hence, proceeding as before, we get—

$$\begin{aligned} I_B &= mI_0\epsilon^{-la} + m(m-1)I_0\epsilon^{-3la} + m(m-1)^2I_0\epsilon^{-5la} + \ldots \\ &= E/(z_0 \sinh la + z_r \cosh la), \end{aligned}$$

which is the same as the formula given above. Following the above line of reasoning, it is easy to understand why every discontinuity in a circuit, such as a leak or an impedance coil, sets up a pair of secondary waves; namely, one that goes on through the impedance and another which is reflected backwards. The final steady state is the harmonic variation of a vector sum at each point, due to all the primary, secondary, tertiary, &c., waves summed to infinity. In many cases this vector sum may be very simply expressed in hyperbolic functions; "but if these functions are not made use of, there is a fearful and wonderful summation." The author also describes a very elegant model to illustrate the propagation of the first outgoing wave-train along a uniform line. A. R.

793. *New Form of Electric Drive.* (West. Electn. 40. p. 457, May 25, 1907.)—M. Johannet, of Paris, has patented the following method of transmitting power electrically from one shaft to another placed in line with it: The first shaft carries the field magnets of a series-wound generator, whose armature is mounted at the end of the second shaft. The second shaft also carries the armature of a series-wound motor whose field is fixed. Included in the circuit is a starting rheostat and an automatic solenoid switch. The latter varies the number of turns in the subdivided field winding of the motor; an increase of current causing the switch to throw more turns into the motor field and so increase the torque. The driving torque exerted on the second shaft is thus the sum of two torques, one being that exerted by the rotating generator field on its armature, and the other being the torque exerted by the motor. A. H.

794. *Electromagnetic Variable Speed Gear.* (Elect. Engineering, 1. pp. 1001–1002, June 13, 1907.)—The following method of power transmission by electrical means has been patented by A. P. Zani: The prime mover is coupled to the armature of a continuous-current machine, whose field magnet is carried by the driven shaft. The latter also carries the armature of another continuous-current machine, whose field magnet is fixed. The speed of the driven shaft may be controlled by varying the excitations of the two fields, and the invention consists of the means whereby this is accomplished. In one arrangement the two fields are connected in series with each other and across a secondary battery. Their junction is connected to the movable arm of a multiple-way switch, by means of which the number of cells across each field may be varied, an increase in the number of cells across one field involving an equal decrease in the number across the other. If the exciting current is obtained from supply mains, two coupled multiple-way switches are used, so connected to suitable field resistances that the cutting out of resistance in one field circuit is accompanied by a simultaneous insertion of resistance into the other. This simultaneous increase of excitation of one machine and decrease of excitation of the other is one of the main claims made by the inventor (Brit. Pat. 11,462 of 1906). A. H.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

795. *Milan-Genoa Electric Railway.* (Electrician, 59. p. 251, May 31, 1907.)—A brief account of the projected electric railway between Milan and Genoa. The line is to be 85 miles long, and the estimated cost is £9,400,000. Power is to be generated by three 24,000-h.p. water turbines. The track is to be double. The passenger trains are to run at 54 m.p.h. on gradients of 1 in 125, and at 80 m.p.h. on the level. They are to be hauled by locomotives combined with baggage cars, each of which will be mounted on two 4-axled trucks, each axle being driven by a 300-h.p. motor. No information is given regarding the system of traction to be used. A. H.

796. *Electrification of Berlin Railways.* W. Reichel. (Elektrische Kraftbetr. u. Bahnen, 5. pp. 201–209, April 14; 221–228, April 24; 241–250, May 4; 265–269, May 14, and pp. 289–291, May 24, 1907. Paper read before the Verein deutscher Maschineningenieure. Écl. Électr. 51. pp. 319–321, June 1, and pp. 353–356, June 8, 1907.)—This paper contains a detailed discussion of the advantages to be derived from the adoption of electric traction on the city and suburban lines of Berlin, of the most suitable system

of delivering power to the car motors, the best type of motor, the cost of the generating stations, and the probable cost of working the lines. An increase in the schedule speed and the number of trains, and a reduction in the cost of fuel, may be confidently anticipated from the electrification of the lines. The various systems of electric traction are passed in review with special reference to their applicability to the Berlin railway system. A 940-volt third-rail system is out of the question by reason of the heavy drop in the rails, and the prohibitive cost of substations. A 4,000-volt continuous-current system would in some ways be feasible, as the construction of 2,000-volt motors (which would be used in groups of 2 in series) presents no serious difficulty, but the objections to it are the impossibility of applying the 4,000-volt current to the lighting and heating of the cars, and to the control system; a motor-generator set would have to be employed for this purpose, which would introduce considerable complications. The 3-phase system is unsuitable on account of the complicated overhead construction, and the difficulties connected with the constant-speed feature of induction motors (the cascade connection could not be used on account of lack of space; while the change-over of the ordinary driving motors from a cascade to a parallel connection would involve very complicated switching arrangements). The single-phase system, with a frequency of 15 to 25, is thus the only one capable of being adapted to the local conditions at a reasonable cost. It is proposed to use a 10,000-volt trolley wire with catenary suspension, and 30,000 to 40,000-volt transmission to the more distant feeding-points. Two types of motor are considered—the Winter-Eichberg and the Siemens-Schuckert one. Preference is given to the latter, as it is lighter and less sensitive to changes of voltage, and as equal division of the load among parallel-connected motors is more easily attained with this type than with the Winter-Eichberg motor. A brief summary is given of the probable cost of the scheme, which provides for 2 generating stations, each of 30,000 kw., at 350 Marks per kw.; 14 transformer substations having a total capacity of 100,000 kv.a., at 30 Marks per kv.a.; 20 km. of overhead system in the city, at 25,000 Marks per km.; 180 km. of overhead system outside the city boundary, at 20,000 Marks per km. (latticed pole construction); 20 km. of cable feeders 10,000 to 30,000 volt, at 25,000 Marks per km.; 310 km. of bare overhead feeders (40,000 volt), at 2,500 Marks per km.; and 120 trains, each consisting of 4 new motor cars and rebuilt trailer cars, at 420,000 Marks per train. The total estimated cost of electrification works out to, roughly, 80,000,000 Marks (£4,000,000); the total length of track being 152 km. The work of electrification is expected to commence shortly. A. H.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

797. *Continuous Current* v. *Single-phase Traction.* **H. M. Hobart.** (Elektrotechnik u. Maschinenbau, 25. pp. 855–861, May 12, 1907. Écl. Électr. 51. pp. 425–429, June 22, 1907.)—This article is in the main a vindication of continuous-current traction for main-line purposes against its single-phase rival. Numerous authorities are quoted to show that there is a consensus of opinion that the single-phase equipment is heavier and less efficient than the continuous-current one. The author maintains that it is at least twice as heavy for a given temperature-rise. The advocates of the single-phase system have insisted on the advantages which

[1] Non-electrical Automobiles are described in the Section dealing with Steam and Gas Engines.

result from the use of a high-voltage trolley line; but in making comparisons with the continuous-current system they have invariably assumed 600 volts as a limit for the trolley voltage in this latter case. The author points out that a trolley voltage of 3,000 is perfectly feasible with continuous currents. Further, this system does not suffer from the heavy reactance drop in the rails which occurs with single-phase currents, and is free from sparking trouble. The author is emphatic in his condemnation of the single-phase system. A. H.

798. *Comparison of Third Rail and Overhead Wire for Electric Traction.* **C. E. Eveleth.** (Street Rly. Journ. 29. pp. 826–827, May 11, 1907. From the "General Electric Co. Review.")—The author compares the third rail, the overhead bridge catenary construction, and the overhead side-bracket catenary construction, giving figures of demerit according to the estimated weights of their respective disadvantages. The points considered are tabulated in parallel columns, and the totals are as follows: Third rail, 14; bridge construction, 50; side-bracket construction, 27. On the other hand, the costs per mile of single-track conductors on these three systems are respectively £1,100, £1,400, and £700, so that in many cases the drawbacks of the last-named system may be more than offset by the lower cost. Special reasons must obtain where the second system is chosen. A. H. A.

799. *High-voltage Direct and Alternating-current Systems of Traction.* **W. J. Davis, Jr.** (West. Electn. 40. p. 394, May 4, 1907. Paper read before the Chicago branch of the Amer. Inst. Elect. Engin., March 26, 1907.) —The author gives some particulars of the more important American high-speed interurban railways electrically equipped recently with 600-volt or 1,200-volt direct current, or single-phase alternating current at 3,300 or 6,600 volts. The total motor h.p. amounts to 43,380, of which 33 per cent. is 600-volt direct current, 27 per cent. 1,200-volt direct current, and 40 per cent. single-phase alternating current. The relative costs of installation per mile of single track, including power plant and rolling stock, are respectively £5,494, £5,284, and £4,894; the operating costs on stated assumptions are respectively £148, £183, and £121 per mile of single track per annum, exclusive of capital charges. The overall efficiencies are given as 71, 71 and 84 per cent., delivered at the cars, and the efficiencies of the car equipments as 75, 75, and 78 per cent.; the power factors are 96, 96, and 85 per cent. respectively. A. H. A.

800. *Electric Traction on Railways.* (Amer. Inst. Elect. Engin., Proc. 26. pp. 235–241, Appendix to paper, Discussion and Correspondence, pp. 242–301, March, 1907.) [For L. B. Stillwell and H. St. C. Putnam's paper see Abstract No. 417 (1907).]—The authors recapitulate the data upon which their calculations are based, and show that the assumed conditions are in accordance with current practice; they also give load curves showing the effect of running at lower speeds than those taken in the paper, the average load on the power station being about the same, but the load-factor less (0·828), and the maximum momentary load much greater (4,720 kw.). They conclude that the estimate of 3,000 kw. per section of 300 miles is sufficient. The effect of grades is negligible as a rule; where recuperation is employed, grades as high as 1·5 per cent. involve only from 40 to 60 per cent. more power than level track. In the *discussion,* **F. J. Sprague** questioned the superiority of the single-phase system over direct current, and urged that on many lines which could properly consider

electric traction the high-voltage direct-current system would give the better results. **B. G. Lamme** dealt with the frequency alone, arguing that for the sake of the greater output and higher voltage at which the motors could be worked, a frequency of 15 cycles was better than one of 25. **B. J. Arnold** objected to premature standardisation, but favoured the 15-cycle frequency, and preferred the high-pressure overhead conductor to the third rail. **W. B. Potter** approved of 15 cycles, and laid stress on the value of commutating poles in direct-current traction motors. **W. S. Murray** stated that the actual cost of repairs of steam locomotives had been found to be 4·05d. per locomotive-mile, compared with 0·9d. with electric locomotives on the Valtelina line. He preferred to leave the standardisation of frequency to the verdict of experience in the future. **O. S. Lyford, Jr.,** described the successful working of the Erie Railroad with single-phase traction on the lines advocated by the authors, and favoured 15 cycles. **C. L. de Muralt** gave data comparing steam with electric locomotives, to the advantage of the latter, which could sustain greater overloads and exert greater tractive efforts than the former. He held that the three-phase motor was superior to the direct-current and single-phase types on account of its constant-speed characteristic, and supported his argument with curves relating to actual locomotives. **A. H. Armstrong** thought standardisation premature, but agreed that the steam locomotive had reached the limit of development, and was far excelled by the electric locomotive. **N. W. Storer** advocated single-phase motors at 15 cycles. **W. McClellan** urged the immediate standardisation of the height and position of trolley wire and third rail, and the voltages and frequency. **W. I. Slichter** discussed the effect of choice of frequency upon the total cost of the electrical equipment. **J. B. Whitehead** pointed out the advantages possessed by alternating-current systems in respect of the simplicity and small number of the substations. **C. Townley** considered that standardisation could only follow practical proof of fitness, which was not yet forthcoming, and discounted the advantages claimed for the lower frequency, as also did **R. D. Mershon. H. M. Brinckerhoff** stated from twelve years' experience that the maintenance costs of an electric railway were at least 20 per cent. less than with steam. He supported the standardisation of certain items. **A. H. Babcock** commented on the lack of data as to actual costs of working, and the fact that a standard frequency of 15 cycles was proposed when not a single installation with this frequency was in operation. **W. S. Murray** gave actual data as to the amount of fuel consumed in steam railway operation; this varied from 0·169 lb. of coal per ton-mile in freight service to 0·885 lb. in express local passenger service. Full details were given, leading to the conclusions that electric single-phase traction required only 60 per cent. of the coal used with steam for the same service, while the locomotive repairs were from three to four times as great with steam as with electricity. **C. Renshaw** explained the cause of unfavourable figures quoted by A. H. Babcock, and the **Authors**, replying to the discussion in detail, claimed that its tendency was emphatically in favour of 15 cycles, and advanced further arguments in favour of single-phase working and early standardisation.

L. B. Stillwell and **H. St. C. Putnam.** (Street Rly. Journ. 29. pp. 457-461, March 16, 1907.)—The Authors reply to G. B. Henderson justifying the data given in the paper, and showing that in actual practice, even under conditions favourable to steam and adverse to electricity, there is a saving of fuel of 50 per cent. with electric traction. Regarding the effect of gradients, while this is important with steam haulage, the authors find that it has no

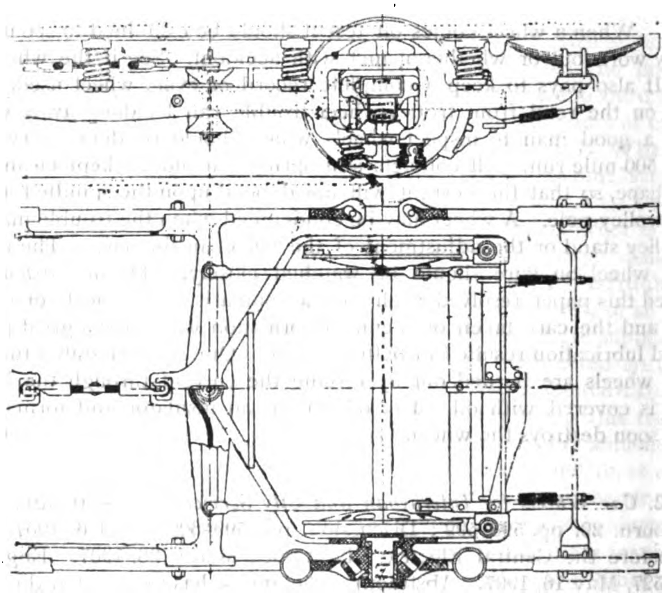
material influence on the energy consumption with electric traction, the consumption being in fact less than on straight level track for gradients up to 0·55 per cent. in passenger service, and 0·85 per cent. in freight service. Taking a section of railway 800 miles in length, with an average of 5·82 trains upon it, the load-factor of the generating station is shown to be 0·97; if stops and delays are allowed for, the load-factor is reduced to 0·828. The generating plant is assumed to have a momentary overload capacity of 100 per cent., and to carry 50 per cent. overload for several hours. On this basis the authors contend that their estimate of generating station capacity is ample. A. H. A.

801. *Trolley Wheels.* **M. M. Baxter.** (Street Rly. Journ. 29. p. 600; Discussion, pp. 600–601, April 6, 1907. Paper read before the Central Electric Rly. Assoc., March 28, 1907.)—In this paper the wheel for the interurban car is considered. Much time and expense will be saved a railway company by using a wheel built for its particular service; hence it pays them to test them thoroughly. Many things are to be considered in testing a new wheel, among which the following are the most important. A car-mile record should be kept of wheel, spindle, and bushing, and also of complaints from conductors. If the wheel held to the wire and if it ran quietly. When a wheel comes off test it should be examined to see if it was entirely worn out or whether it met with accident. See if the wheel wore true. It also pays to keep a complete record of every wheel used. Many delays on the road from trolley-wheel trouble can be done away with by having a good man to inspect wheels, which should be done every day, or after a 500-mile run. All contacts and springs should be kept clean and in good shape, so that the current will not depend upon the spindle for a path to the trolley-pole. A wheel may be condemned when the trouble may be in the trolley stand or the adjustment of the wheel in the harp. The pressure of the wheel on wire should be watched closely. The *discussion* which followed this paper resolved itself into a comparison of wheels of different makes and the care taken of them. Lubrication was made a great point of, as good lubrication resulted in better service. One speaker stated that many trolley wheels are burned out by forcing the current through the bushing, which is covered with oil. The oil acts as an insulator and forms an arc, which soon destroys the wheel. C. E. A.

802. *Car Wheels for Interurban and City Service.* **C. Skinner.** (Street Rly. Journ. 29. pp. 598–599; Discussion, pp. 599–600, April 6, 1907. Paper read before the Central Electric Rly. Assoc., March 28, 1907. Eng. News, 57. p. 527, May 16, 1907. Abstract.)—The author has interpreted this subject to mean "Wheels for heavy interurban cars, operated over interurban and city tracks," and has borne in mind only the operation of high-speed equipment weighing 40 tons or over per car. The specifications of the Master Car Builders' Association should be adhered to as nearly as possible. It is occasionally necessary to reduce the size of the wheel flanges somewhat, and a reduction to 1⅛ in. or 1 in. in depth and to 1¼ in. or 1⅛ in. through the throat is quite safe, but the 4-in. tread is essential to safe tracking, in the writer's opinion. The flangeless brake-shoe is considered best for service in which heavy cars are operated over grooved rail in city streets, as it does not increase the flange wear. The question of safety in tracking is a very important one. The author closes with a *résumé* of the experience of his

Company—the Scioto Valley Traction Co.—with the wheel question. A diagram is given showing the wear on interurban steel-tyred wheels caused by running over grooved rails. The excessive wear is on the inside of the flange. The wheels shown had only been on 8 months and the mileage made was 28,000 miles. Some idea of the excessive wear may be seen by comparison with the life of the same wheel under equipment of equal weight on steam railroads, when it is not unusual to obtain a mileage of about 200,000 miles between turnings. The excessive wear coming at the angle it does shows a very severe wedging tendency, which finds its weakest point at the wheel and axle fit, and it is almost impossible to maintain an immovable wheel. Wheels for this class of service should be pressed on at about 90 tons with a minimum of 70 tons. In the discussion which followed it was pointed out that the importance of mating wheels was not fully appreciated, and was a matter which should have greater attention. C. E. A.

808. *Warner's Swing Radial Truck.* (Tram. Rly. World, 21. pp. 202–203, March 7, 1907.)—This is a device, which has recently been patented, to produce a perfect steering control for railway and tramway wheels. On reference to the Fig. it will be seen that the motors are pivoted at points



between the axles in a manner well known to-day. The whole car then hangs on links, each about 1 ft. in length, there being two to each axle-box, and the result of this extremely simple arrangement is a peculiar movement. A truck, with the patent applied at one end, has already had twelve months' regular service, and it is claimed that even without the control of alignment springs, no over-swing results, whilst on straight track the car body always preserves an unusually comfortable dead straight riding. Another important claim for this truck is that the traction is reduced not only by the absence of oscillation obtained by the longer wheel base, but, owing to the extremely delicate accommodation to track sinuosity and accurate training of the wheels

at any instant, the total traction resistance is from 5 to 10 per cent. less than with any other truck. A reduction in flange wear is also claimed, which must mean at least an equal reduction in rail wear; the cost for current, which would have performed the work of wear, is also reduced. Illustrations are given, including one showing radial movement of sub-truck. C. E. A.

804. *Fogarty's Sectional Gear Wheel with Interchangeable Rims.* (Street Rly. Journ. 29. p. 798, May 4, 1907.)—A number of changes in J. F. Fogarty's sectional gear wheels with interchangeable rims are dealt with. The first is that the car wheel and the permanent hub of the gear wheel are cast as one. This removes the necessity of pressing on both the wheel and the hub separately. It was also found to be too expensive to mill out the tool casting, because of the rapid using up of the tools, so a female V has been put in the cast iron at an angle of about 15°, which makes it easier to prepare the hub and lessens the cost. The practice of having the gear on the inside of the hub has also been adopted. This adds still further to the ease of handling the rims, especially where solid wheels are used, and tends towards reducing the time required for replacing the rims, which is about an hour. C. E. A.

805. *Recent Experience with Corrugated Rails on the Boston Elevated Railway System.* **A. L. Plimpton.** (Street Rly. Journ. 29. p. 821, May 11, 1907. Elect. Engineering, 1. p. 958, June 6, 1907.)—One of the worst pieces of noisy corrugated track on the system of the Boston Elevated Railway Co. has recently had to be rebuilt, and special attention was paid to it in order to prevent a recurrence of the difficulty in the new track. Screw spikes were used, as having much greater holding power than the ordinary spikes. The concrete was allowed to set ten days before the first car was operated over it. As one cause of corrugated rail is considered to be the constant tendency of the wheels to climb up over the outside rail of the curve, it was determined to use a guard rail on the inside and to build the track wide gauge, so that the wheels would not touch the gauge line of the outside rail, the car being wholly guided by the guard of the inside rail. The outside rail was also elevated above the inner one on each track. After an interval of five months a careful examination of the track was made and showed heavy marks of corrugation throughout. The writer therefore has come to the conclusion that it is impossible to correct this difficulty by any method of track construction, and that the difficulty is wholly with the type of trucks now in use. He thinks that the only effectual remedy will be to so design the trucks that the wheels will turn independently of each other, and also that the axles will always be on radial lines. This, however, introduces such serious mechanical difficulties that corrugation may be the lesser evil. C. E. A.

806. *Track Bonding.* **T. B. McMath.** (Street Rly. Journ. 29. pp. 596–597; Discussion, pp. 597–598, April 6, 1907. Paper read before the Central Electric Rly. Assoc., March 28, 1907.)—The author first traces the evolution of track bonding. The standard bond now in use in Indianapolis is a No. 0000 10-in. flexible bond, with 7/8-in. compressed terminal. The chief difficulty in connection with this bond is in the connection of the flexible strand or rib on wire with the terminal. Certain heat conditions, together with proper manipulation at the exact moment, are essential to the construction of a good bond. For testing the union of ribbon or strand wire with the terminal the following is suggested: Hold the head of the bond firmly in a

vice, then, after cutting the strands some 2 or 3 in. from the head, bend them back against the terminal. Then take the individual wires and separate them from the head by a strong, sharp jerk. This will show, relatively, any reduction in area, brittleness, and possible defect at their junction. The author then touches on various difficulties met with in bonding. Plastic bonds are not usually a success. The use of a bond brazed to the rails by means of an electric brazing device gives the best contact that can be obtained. The discussion which followed was largely confined to the method of drilling holes and to the use of brazed bonds. C. E. A.

807. *Track Construction in Dallas, Texas.* (Street Rly. Journ. 29. p. 691, April 20, 1907.)—The track construction used, while of the stringer type, differs somewhat from that used in other cities. No heavy cross-ties are employed, and a second tie-rod is clamped to the base of the rail at points equi-distant from the round rods. The concrete stringer proper under each rail is 18 in. wide and 13 in. high, but it is an integral part of the 7-in. bed of concrete placed between the rails and tracks and extending to the curb line. The concrete is a mixture of 1 part cement, 3 parts sand, and 6 parts limestone, and is always allowed to set seven days before the cars are permitted to run on it. Grooved 9-in., 95-lb. rails, in 60-ft. lengths, are used. These are bolted together with 8-bolt continuous rail joints, and are electrically connected with two 210,000-circ. mil plug bonds. The track construction at a steam road crossing is described. C. E. A.

808. *New System of Block Signalling on the Pennsylvania Railway.* (Eng. News, 57. pp. 506–507, May 9, 1907. Engineer, 103. p. 596, June 14, 1907.)—The special features may be enumerated as follows: 1. The semaphore arms move upward instead of downward from the horizontal position ("stop") to the inclined ("caution") and vertical ("clear") positions. 2. Two semaphore arms and two lights are used for every indication, except those governing low-speed movements; for these latter an additional small arm and dim light are provided. 3. The signals are used to give two kinds of indications when at the "stop" position: (A) Stop, wait a specified time, and then proceed; (B) Stop and remain until the signal indicates "proceed." The former is distinguished by a longer upper arm and the two lights offset from a vertical line. The latter is distinguished by having the arms of equal length and the lights disposed in a vertical line. 4. At interlocking plants, the signals indicate for speed rather than for routes. Diagrams are given showing these signal positions. Two interlocking plants are included in this installation. These are mechanical, but all signals are electro-pneumatic. Compressed air at 90 lbs. per sq. in. and electricity at 500 volts are furnished from a centrally located plant. The air is transmitted through a 2½-in. main and the electricity by a No. 6 copper wire. Electricity for operating the track circuits and signals is taken from storage batteries located at the various signals. The batteries are charged in series from the 500-volt supply, eight hours at a time, four nights a week. The batteries have chloride accumulators, each signal pole being supplied with two cells. One cell is used to operate the 16-ohm signal cylinder magnets and also to feed the track circuit in the rear through a 1-ohm resistance in connection with the rails. The other cell is in circuit ready for charging. The system of circuits is known as the "polarised wireless," the only wires used being those for the charging line, approach indicators, locks for interlockings, and indica-

tion locks of the signals. The signal cylinders are tandem and the arms are pulled to the "clear" position by a $\frac{5}{16}$-in. rod instead of being pushed to that position by a $\frac{3}{4}$-in. pipe or 1-in. rod. This new construction saves considerable power. The relays are 5-ohm universal, neutral polar, and the pole changers are pneumatic. An ordinary mechanical pole changer, however, would probably be as well suited to the work. All switches are equipped with rotary circuit controllers which shunt the track through two No. 6 wires when switches are open. E. O. W.

809. *Single-phase Electric Traction.* C. F. **Jenkin.** (Inst. Civ. Engin., Proc. 167. pp. 28–67; Discussion, pp. 68–101, 1906–1907.)—The author reviews the progress made since 1902, and gives data relating to the working of the Valtelina Railway, and lists of the single-phase railways and tramways which have been constructed. He then considers the various types of single-phase motors, explaining briefly the general principles of their action, and comparing their respective advantages. There is no loss of tractive effort due to the pulsating torque of the motor, which has been proved capable of hauling a greater load with a less adhesion-weight than a steam locomotive. The temperature-rise can be controlled by means of artificial ventilation. Regulation is best effected by varying the number of secondary turns of the transformer, with contactors, of which five suffice for speed control and two for reversing. A long-pull electromagnet for actuating the contactors is shown, with performance curves. Low-voltage glow-lamps can be used for lighting the trains in spite of the low frequency, the maximum voltage permissible at 16 cycles being 85. The drop in the rail return is important; the author quotes J. J. Thomson and F. Lydall to the effect that the equivalent resistance of an iron bar may be represented by that of a shell of definite thickness, and that the internal reactance of the bar is equal to the resistance of the equivalent shell; for a rail the circumference of the shell equals the periphery of the rail, and experiments show that the thickness of the shell may be taken as 2·9 mm. for 18 cycles, 2·7 mm. for 25, and 1·7 mm. for 50 cycles per sec. Formulæ are then given for the inductance of the trolley wire and rail, and a table of actual results obtained on the Marienfelde-Zossen line is given. Various methods are described of minimising the drop in the rail return, by booster transformers, &c., in order to reduce electrolysis, interference with other circuits, and shocks to persons touching the rails. Of these troubles, interference seems to be the most important, especially as affecting telephone circuits. Telegraph instruments can be effectively shielded by inductance or capacity, but telephone circuits can only be protected by cabling. Dangerous electrostatic charges may be induced by the high-voltage trolley wires on neighbouring wires, which must therefore be earthed or put underground. Automatic signalling with track circuits can easily be employed. The trolley wire must be suspended at a uniform level, and arranged for underneath collection. A single catenary carrying a horizontal auxiliary wire, from which the trolley wire is suspended by sliding clips, is the best for moderate spans (150 ft.), as it enables the variations in length of the trolley wire to be taken up by tightening gear. With suitable porcelain petticoat insulators there is practically no limit to the trolley pressure available. Methods of supporting the overhead construction on poles and in tunnels are shown. The collector must be of the bow type, with minimum inertia. The author's conclusion is that the single-phase system is the best for general use on English railways. The paper is fully illustrated. In the *discussion*, **A. Siemens** referred to the successful results of the Zossen

experiments, and remarked that, when the engineering problems had been solved, the deciding factor was commercial efficiency. **T. H. Schoepf** argued that the low-pressure direct-current system possessed certain advantages. He favoured the compensated series motor rather than the repulsion type, but objected to commutating poles. The low axle speeds on heavy work introduced great difficulties. He advocated pneumatically-worked control. **H. E. O'Brien** pointed out the difficulty of installing high-voltage overhead equipment on a complicated railway system, and the serious results of damage to the trolley line; and he strongly supported the third-rail direct-current system, mainly on the score of cost. **F. D. Fox** referred to the application of the system to tube railways. **A. P. Trotter** described experiments on electrolysis with alternating currents, concluding that there was not much ground for fear in this respect. He did not see the necessity for an auxiliary suspending wire, and expressed a preference for double insulation. **P. Cardew** advocated the adoption of a uniform system throughout Great Britain, and pointing out the possibility of obtaining a unidirectional current from an alternating-current system, with consequent electrolysis, he suggested that both poles of the system should be insulated, in which case the three-phase system might be preferable to the single-phase. **W. M. Mordey** said the Ward-Leonard single-phase system was not dead, and referred to the advantages of "Stalloy" in reducing the losses and heating in single-phase motors [see Abstract No. 164 (1907)]. The absence of regeneration caused excessive losses on lines with frequent stops. He preferred copper to iron for the return conductor. **R. T. Smith** thought that electricity could not compete with steam for traction without great reduction in the cost of energy, and that railway motor cars effected the same results as electric traction. The possible variation in position of the overhead conductor was a great advantage; standard limits should be fixed. The remodelling of telegraph and telephone circuits to avoid interference might involve serious expense, and the overhead construction would obscure the signals. **B. M. Jenkin** regarded artificial cooling of the motors as but a slight drawback, and pointed out that the economical speed regulation of alternating-current motors was far more economical than that of direct-current motors. Single cars at frequent intervals might be preferable to long trains. **F. W. Carter** pointed out the difficulty of ventilating motors without introducing dust and damp into the windings, and stated that the bridges on some English railways came within 2 in. of the top of the loading-gauge. Comparing single-phase with direct-current working, he showed that a three-coach train on the L. B. and S. C. Rly. required as much driving machinery as would suffice for an eight-coach train on the Inner Circle, while the cost of construction and maintenance of the single-phase equipment was considerably greater than with direct current. As electrification had been proved economical only in the case of urban service, for which the single-phase system was inferior to the direct-current system, he disagreed with the author's conclusion that the former was preferable, except for light traffic with few stops. He deprecated the electrification of main lines of railway. In his reply, the **Author** showed curves comparing the start of the compensated series motor with that of the repulsion motor, and dealt with the points raised. By correspondence, **A. C. Kelly** advocated pneumatic control in preference to the electromagnetic system shown by the author, and said that with the single catenary suspension temperature variations gave no trouble; 800 miles of line had been erected without tightening gear. **T. Stevens** referred to the loss of adhesion with alternating current, and showed that there were 800 miles of single-phase

railway in service and under construction. E. C. Thrupp said that to run separate cars at frequent intervals was impracticable in railway working, and advocated generating stations 6 to 12 miles apart supplying direct current to the lines, giving estimates of capital and working costs favourable to this system. He considered the electrification of main lines a matter worthy of close attention where the traffic was congested. A. H. A.

810. *Train Resistance and the Economics of Railway Location.* (Eng. News, 57. pp. 580–583; Discussion, pp. 583–584, May 16, 1907. Abstract of Report presented to the Amer. Rly. Engin. and Maintenance of Way Assoc.) —On account of the demand for cheaper rates and better service, and the competition of other railways, particularly those new lines designed on modern economic principles, many railway organisations have been obliged to thoroughly revise their existing permanent ways. Locomotives and rolling stock generally have been increased in size, weight and capacity in the effort to reduce train mileage; and such changes have entailed bridge structures of increased strength, heavier rails, more secure joints, more and better ballast, wider road-bed, and consequently an improved railway. Besides this, more direct routes are taken in some cases and new lines constructed, in others the grade and alignment features alone are altered. The Report investigates the conditions under which such revision is necessary and to what degree the existing lines should be altered in order to secure most economical working. With a given volume of traffic, the most economical location is the one for which the sum of fixed charges and operating expenses is a minimum; and, for an existing line, a more economical location is obtained when interest and renewal charges on the additional expenditure for construction are more than saved by the decreased operating expenses. As regards temporary lines, cases may arise in new construction, in territory where the topographical features are extreme and the financial aspect a governing element, in which it is necessary to construct a temporary line with a gradient steeper than the limiting one. This line will be used until future traffic conditions justify the construction on the alignment as projected. Unless such a temporary line can be used afterwards as a branch or local line, it should be avoided, as a much heavier traffic is needed to justify the abandonment of a temporary line than would justify the construction of a permanent line designed for heavy traffic.

Figures are given relating to a low-grade 59-mile line built to replace an existing 83-mile line with sharp curvatures and heavy grades, thus saving 24 miles of distance. The old line was not abandoned, but used for trains of empty coal and coke cars. The traffic in 1904 was handled entirely on the old line, and in 1905 on the two together, and after allowing for a growth in business of 22 per cent., it was estimated that the saving in operating expenses in 1905, resulting from the construction and operation of the new line, amounted to nearly 5 per cent. of the total cost of the new line, thus quite justifying its construction.

The rest of the Report is devoted to a review of the many experiments that have been made on train resistance, the committee considering this to be the basis of the study of the economics of railway location. The resistance due to gradient is obviously capable of exact mathematical determination, and is equal to 22 lbs. per metric ton per 1 per cent. of gradient. As regards the resistance on a level tangent, the committee is of the opinion that the differences in many of the proposed formulæ can be explained in that trains of various weights were used under various conditions on tracks of

various qualities, and that a suitable formula could be found if experiments were made under present conditions. For heavy freight trains at low speeds, this formula would have the form $r = a + bV$, where r is the tractive resistance in lbs. per ton, and V the speed in m.p.h.; a and b are constants. Reference is made to two papers on train resistance; in the first, read before the Amer. Soc. C.E. June, 1903, by A. C. Dennis, the figure 5·2 lbs. per metric ton is given as the tractive resistance for a 2,000-ton train, for all speeds between 7 and 35 m.p.h. These data were the result of many experiments. In the other paper, by A. K. Shurtleff, the following figures are given: As starting resistance 15 lbs. per metric ton per 1,000-ton train, and as train resistance for speeds from 7–30 m.p.h., the following formula is given—

$$R = 1 + 80/W,$$

where R = resistance in lbs. per metric ton, and W = average weight per car in metric tons. In both the above cases the pull measured in the experiments was the drawbar pull behind the engine. In the *discussion* which followed, several examples were given of lines on which the gradients and curves had been reduced, enabling the engines to pull heavier trains without increased fuel consumption. Other points discussed were the saving in expenditure by the use of momentum grades, the effect on the schedule time of waiting in sidings on single-track railways, and the placing of signals and sidings when momentum grades were employed. H. M. H.

ELECTRIC LAMPS AND LIGHTING.

811. *Blondel enclosed Flame Arc Lamp.* (Brit. Pat. 4,677 of 1906. Elect. Engineering, 1. pp. 521–522, March 21, 1907.)—In this lamp the gases containing fumes are drawn immediately after their production through an outlet opening arranged around the arc, and are returned after purification through a return opening arranged below the former opening and substantially in the same axis, so that the column of gases rises direct from the return opening to the outlet opening, following the shortest possible path and surrounding the arc without removing it out of its normal position. The circulation of the gas is produced by a fan or by a thermo-syphon, *i.e.*, a large cylindrical condensing reservoir divided into two parts by a cylindrical partition. In addition to the condensation of the fumes on cold surfaces, the gases are purified by being passed through metal nettings and purifying substances, such as alkaline carbonates, salts of protoxide of iron, or simple iron shavings. By thus preventing diffusion of the fumes throughout the globe, deposition of these fumes on the glass is to a large extent prevented, and by continuously circulating substantially the same air past the arc the combustion of the carbons is reduced. Five forms of the arrangement are illustrated. C. K. F.

812. *The Moore Tubular Light.* **D. McFarlan Moore.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 523–559, April, 1907. Electrician, 59. pp. 842–845, June 14, 1907. Ind. Élect. 16. pp. 300–304, July 10, 1907. Abstracts.)—The author gives a detailed description of the mechanical and electrical construction of the Moore vacuum tube, and discusses the theoretical considerations connected with the obtaining of light from gaseous conductors within glass tubes. The continuous tube used by the author terminates in a rigid steel box, which contains besides the two carbon electrodes of the tubes a step-up

transformer and a small, specially designed automatic valve, the latter being a very important accessory for the successful working of the vacuum tube system of lighting. The high-potential terminals of the transformer always remain within the box, so that no shock can be felt on touching the glass. The function of the feeder valve is to permit air or other gases to enter the tube only when it is needed, and in such a manner that it is entirely automatic. The tubes are now used in lengths varying from 40 to 220 ft., and are built up by hermetically sealing together 8 ft. 6 in. lengths of 1·75 in. diam. with walls $\frac{1}{16}$ in. thick. The efficiency of the illumination does not vary over a wide range of supply voltage. The degree of vacuum required in these tubes is about 0·10 mm. It is possible to use these tubes graduated from an intensity of light per ft. that is almost negligible up to 80 or more Hefner candles per ft. The average long tube now in use is estimated to operate at 12 Hefner candles per ft. The colour of this light can be changed at will over a wide range. This is accomplished by changing the character of the gas within the tube. If the tube is permitted to feed itself on plain air a pink light results, but if the air is first caused to pass through a cylinder of phosphorus to absorb its oxygen a golden-yellow light is produced. When these tubes are supplied with CO_2 the light appears pure white, the spectrum remaining absolutely constant. The colour of the light can be varied by feeding the tube with any gas, as each has its own spectrum, or by using multiple valves, &c., mixing the various gases between the lighting tube itself. It is claimed that for art galleries, surgical operating tables, show-rooms, &c., this method of illumination could be used with great advantage. The article is fully illustrated, containing a series of diagrams, tables of comparison, and photographs of actual installations carried out. [See also Abstract No. 1088 (1906).] L. G.

813. *A Conducting Nernst Filament.* (Elect. Engineering, 1. pp. 890–891, May 23, 1907. Elect. Rev., N.Y. 50. p. 986, June 15, 1907.)—This is an abstract of a patent taken out by Nernst and Stockem (Brit. Pat. 15,915, of 1906). Tungstic acid may be mixed with thoria or zirconia, and then heated in an iridium crucible by an oxyhydrogen blowpipe until combination takes place and tungstate of thorium or zirconium is formed. The tungstate is then powdered and heated in an atmosphere of hydrogen, whereby a mixture of tungsten and zirconia or thoria is formed. The resulting powder is made into filaments, which have a sufficiently long life for practical purposes, especially on alternating current. These lamps conduct without preliminary heating and should be burnt in a vacuum or in an indifferent atmosphere.

W. H. S.

814. *Comparative Cost of Gas and Electric Lighting.* E. G. Kennard. (Elect. Engin. 39. pp. 540–542, April 19; 578–576, April 26, and pp. 612–615, May 3, 1907. Paper read before the Students' Section of the Inst. Elect. Engin.)—In the comparisons the kilo-candle hour, *i.e.*, 1,000 candle hours, denoted by KC.H., has been taken as a basis. The cost of electric energy per KC.H. is obtained by multiplying the watts per candle by the price per unit. Four items make up the total lighting costs: (1) Energy; (2) renewals; (3) capital charges; (4) maintenance. After considering the lives of the various electric glow-lamps, and their efficiencies at various c.p.'s and voltages, a table is given of all the items of cost for the principal sizes and types of these lamps. This is followed by curves giving the relative total costs per hour, the minimum c.p.'s obtainable with different glow-lamps

of various rated voltages, and the most economical lamps to use where single units of low c.p. are required. At the average London price of 4·2d. per unit, the 25-c.p. "osram" lamp is the cheapest for 100-volt circuits, working out at 180d. per 1,000 hours, but for single lamps of low c.p. on 200-volt circuits 16-c.p. high efficiency carbon lamps are still the cheapest at 310d. per 1,000 hours. Similar figures and curves are then given for continuous and alternating arc lamps, the final costs, at 4d. per unit being:—

Electric.		Gas.	
12-amp. yellow flame arc	0·9d. per KC.H.	670-c.p. high-pressure mantle	2·1d. per KC.H.
6-amp. Blondel arc	1·0	490-c.p. self-intensive mantle	2·8
8-amp. yellow flame arc	1·4	56-c.p. Welsbach mantle	3·0
8-amp. white flame arc	1·8	38-c.p. inverted	3·4
Cooper Hewitt lamp	2·7	210-c.p. gas burner	3·7
10-amp. open arc	3·6	16-c.p. Argand burner	10·0
6-amp. enclosed arc	6·9	14-c.p. bats-wing	12·0

The gas lamps considered are: (1) Argand burner; (2) bats-wing; (3) gas arc lamp; (4) high-pressure gas lamps; (5) inverted mantles; (6) self-intensive type; (7) Welsbach upright mantle. A table is given of a collection of tests made by various authorities on gas lamps, and also a table of costs comparable with those for electric lamps. At the average London price of 33d. per 1,000 cub. ft. the costs shown in the second column of the above table are obtained. The paper concludes with three sets of curves showing the relative costs of (1) 40–60 c.p., (2) 300–400 c.p., (3) 600 c.p., electric and gas lamps. For London the relative costs are: (1) For 50-c.p. lamps gas is 50 per cent. the cost of electric light; (2) for 300 c.p. the costs are equal; (3) for 1,000 c.p. and over gas costs twice as much as electric light. In the lighting of large spaces flame arc lamps are the cheapest.

H. F. H.

815. *Comparative Cost of Domestic Lighting by Gas and Electricity.* **L. W. Wild.** (Electrical Times, 31. pp. 776–777, May 23, 1907.)—In this article the cost of lighting a house with two sitting-rooms, kitchen, scullery, hall and landing, dressing-room, three bedrooms, bath and lavatory for one night, with gas at 3s. per 1,000 and electricity at 5d. per unit, and including cost of renewals with C mantles at 4½d., inverted mantles at 6d., carbon lamps at 10d., tantalum lamps at 2s. 9d., and "osram" lamps at 4s. each. Burning hours: 5 for hall and landing, 4 for kitchen, 3 for sitting-rooms, 2 for scullery, 30 min. for each bedroom and dressing-room, and 10 min. for bath-room and lavatory, and allowing for by-passes the costs are as follows:—

C burners throughout	6·47	pence.
C and inverted burners	4·54	„
Carbon lamps	7·66	„
Tantalum lamps	7·18	„
"Osram" lamps	5·21	„
Carbon, tantalum, and "osram" lamps	4·28	„

Thus electricity with carbon lamps is 19 per cent. dearer than gas with C burners, but with the best combination of both gas and electricity gas is 6 per cent. dearer than electricity. The paper also includes some useful tables, including one giving the distribution of light at different angles for all the above-mentioned illuminants.

C. K. F.

816. *New Form of Selenium Photometer.* **E. Presser.** (Elektrotechn. Zeitschr. 28. pp. 560–561, May 30, 1907.)—The principle underlying the various new forms of selenium photometer described by the author is the rapidly alternating exposure of a selenium cell to the two luminous sources under comparison. One of the forms described is arranged as follows: Between the two sources is placed a small motor coupled to an alternator, the axis of the two being normal to the photometric bench. At the end of the motor-generator shaft is carried a mirror inclined at an angle of 45° to the shaft. As the mirror rotates, it receives light from the two sources alternately. The light reflected by the mirror falls on a selenium cell which is connected in series with the small alternator and a continuous-current indicating instrument. If the luminous fluxes received by the mirror from the two sources are equal, the positive and negative half-waves of current will also be equal, and the continuous-current instrument will remain at zero. But if the flux from one source exceeds that from the other, the resistance of the selenium cell will be less during one half-wave than during the other, and so a deflection of the instrument will result one way or the other. The new photometers are being made by H. Bumb, of Berlin. A. H.

817. *Steinmetz's Integrating Photometer.* (West. Electn. 40. p. 542, June 15, 1907.)—This photometer is for measuring the mean spherical c.p. of any kind of lamp. It consists of a large number of mirrors mounted on a circular stand with the lamp, which is capable of rotation, suspended at the centre of the circle. The direct rays are prevented from falling on the photometer head by means of an opaque screen, and the mirrors are arranged at such angles that the illumination of the photometer head produced by the reflected rays is proportional to the mean spherical c.p. The proper position of the mirrors in practice is obtained by covering all but one, and then adjusting this one till the ray reflected from it falls directly on the photometer screen. The mirrors have each to be sufficiently large to show the entire image of the lamp to an eye situated at the screen. It is suggested that devices like spectroscopes, bolometers, thermo-couples and the like may also be used instead of a photometric screen. The invention may also be employed to determine the total flux of any kind of radiation emitted by a body. Although the patent was only issued on April 2, 1907, it was applied for on Oct. 13, 1902 (U.S. Pat. 849,027). A. R.

818. *The Speed of Flicker Photometers.* **J. S. Dow.** (Electrician, 59. pp. 255–257, May 31, 1907.)—The author gives the results of experiments showing the connection between the sensitiveness of a flicker photometer and the speed at which it is driven. The type of instrument used was similar to Wild's [see Abstract No. 992 (1906)]. The grease-spot disc was driven at a constant speed by an electrical phonograph motor. One of the lights being compared was moved to obtain the balance. The sensitiveness of the photometer was defined as follows: The light-source having been moved until a balance is obtained, the positions on either side of this point, in which it could just be seen that the photometer was out of balance, are noted. The mean of a set of these observations enables us to measure the change of illumination on either side of the balance position, which can be definitely detected. The reciprocal of this quantity is called the sensitiveness of the photometer. When comparing lights of the same colour, under the very best conditions, a change of illumination of about 1·7 per cent. on either side of the photo-

metric balance could be detected. With a Lummer-Brodhun instrument much better results could be obtained. The relation between speed and sensitiveness when the lights compared are of the same colour is first investigated. The results show that for illuminations above 10 candle-metres the sensitiveness follows practically the same law. The sensitiveness is great over the range of flicker frequency lying between 450 and 1,100. For illuminations below about 5 candle-metres the higher speeds are inadmissible, the range of frequency over which the sensitiveness is great is much more restricted and the maximum sensitiveness is much smaller. The author's experience shows that the illumination must be greater than 2 candle-metres for satisfactory working. When lights of different colour are compared it is found that a much higher speed is necessary in order to obtain the maximum sensitivity, and any appreciable variation above or below this speed considerably lowers the sensitiveness. Great accuracy cannot be attained in flicker photometry, as the ability of the eye to detect flicker is variable from day to day and fatigue is easily produced. The eyes of different observers also seem to be affected in different ways by flicker. All the experimental results given were obtained by the author. A. R.

819. *Frequencies of Flicker at which Variations in Illumination Vanish.* **A. E. Kennelly** and **S. E. Whiting.** (Electrical World, 49. pp. 1208–1209, June 15, 1907. Abstract of paper read before the National Electric Light Assoc., June 5, 1907.)—The results of experiments on flicker in illumination produced by alternating currents of various frequencies are given. It was found that the frequency at which flicker ceases to be visible is approximately the same for different observers with normal sight. The maximum frequency of vanishing flicker with stationary target and stationary eye is about 66. Vanishing-flicker frequency increases in all cases when the illumination on the target is increased, but not in the same proportion. The increase of vanishing-flicker frequency with illumination is rapid when the illumination on the target is increased, provided that this illumination is less than 0·5 of a candle foot and has a 100 per cent. range, but it increases slowly for higher illuminations. It apparently does not appreciably depend on the manner in which the illumination varies when passing from its maximum to its minimum values. The vanishing-flicker frequency increases slightly with the area of the target. The greater the amplitude of the variation of the flicker the greater the vanishing-flicker frequency. The smallest range of flicker that was found to be observable was 1·4 per cent., and this was only observable at a low frequency. The most sensitive flicker frequency for small ranges of flicker was in the neighbourhood of 2·5. Flickering ceases to be objectionable with ranges less than 7·5 per cent. The conditions favourable to disagreeable flickering with fixed target and fixed eye are powerful illuminations, large flicker ranges, bright surfaces of large area, and low frequency. The intensity of the sensation of flicker may be measured by the vanishing-flicker frequency—that is, the frequency necessary to make the flicker disappear. The law of flicker sensation in relation to flicker stimulus is similar to the law of steady luminous sensation with steady luminous stimulus, which is generally admitted to be well represented by the Weber-Fechner law. Constant ratios of increase in flickering illumination are accompanied by equal increments of vanishing-flicker frequency. Doubling the intensity of flickering illumination adds approximately 8·8 to the vanishing-flicker frequency. The vanishing-flicker frequency plotted vertically on a uniform scale against the luminous intensity plotted horizontally on

a logarithmic scale gives a straight line. The results of a series of observations with different targets and illuminations plotted out in the above manner gave parallel lines. The vanishing-flicker frequency may be represented by 11 log *m*, where *m* depends on the size, colour, quality, and distance of the object illuminated. The experimental results, with one exception, show that *m* is proportional to the flicker range. A. R.

REFERENCES.

820. *Kelvin's Law of Economy.* **F. G. Baum.** (Electrical World, 49. pp. 1029–1031, May 25, 1907.)—The author gives formulæ and curves intended to facilitate the application of Kelvin's law of economy in various practical cases. A. H.

821. *Dolter Surface Contact System at Torquay, Mexborough, and Hastings.* (Tram. Rly. World, 21. pp. 181–188, March 7, 1907.)—In this article the author proceeds first to indicate the arrangements of the Dolter system as carried out on the Continent, and then goes on to describe the details of the stud and box as improved in the English installations. The changes lie principally in improvements of the stud, in the magnetising of it, in the shape of the contact box, and in the method of connecting it to the cable. After this general survey of the system the application of it in the three installations at Torquay, Mexborough, and Hastings is given. C. E. A.

822. *Plotting of Speed-time Curves.* **A. S. Langsdorf.** (Electrical World, 49. pp. 989–990, May 18, 1907.)—The author explains a graphical method of deriving the speed-time curve from the speed-acceleration curve. A. H.

823. *Corrugation in Tramway Rails.* **K. Sieber.** (Elektrische Kraftbetr. u. Bahnen, 5. pp. 329–333, June 14, 1907.)—A general discussion of the causes of and possible remedies for corrugation. L. H. W.

824. *Treatment of Railroad Ties in New Jersey, New York, and Pennsylvania.* **L. Bush.** (Eng. Record, 55. pp. 482–485, April 20, 1907.)—The author has discussed at great length the subject under the following headings: 1. Native timbers which are available; 2. Best method of preparing these timbers for treatment; 3. Methods and cost of treatment; 4. Plant for treating ties. The author touches on the question of the type of fastening in connection with the question of treatment, which should receive very careful consideration in order to realise the proper and full value from treatment. C. E. A.

825. *Temperature and Selective Radiation of Glow-lamps.* **C. W. Waidner** and **G. K. Burgess.** (Bureau of Standards, Bull. 2. pp. 319–329, Dec., 1906.)—The full paper corresponding to Abstract No. 2024A (1906).

826. *The Rotating Lamp Method in Photometry.* **E. P. Hyde** and **F. E. Cady.** (Bureau of Standards, Bull. 2. pp. 415–437, Dec., 1906.)—The full paper corresponding to Abstract 1457 (1906).

827. *New Selenium Photometers.* (Schweiz. Elektrot. Zeit. 4. pp. 253–254, June 1, 1907.)—This article contains a general discussion of the advantages of selenium photometers. Selenium appears to be susceptible to the different colours very much in the same relative degree as the human eye, and hence would seem to be admirably adapted for use in a standard photometer. The arrangements adopted in the new types of selenium photometer [Abstract No. 816 (1907)] are described. A. H.

828. *Leading-in Device for Incandescent Electric Lamp.* (Electrical World, 49. p. 583, March 23, 1907.)—In this short note the method is described by which the Whitney lamp is manufactured, dispensing entirely with platinum as the material for the leading-in device, and replacing same with copper or iron. L. G.

829. *Utica-Syracuse Electric Railway.* (Street Rly. Journ. 29. pp. 996–1009, June 8, 1907. Elect. Rev., N.Y. 50. pp. 1021–1024, June 22, 1907.)—A fully illustrated account of the arrangements adopted in connection with the electrification of this line. The main features of the system have already been described in Abstract No. 869 (1906). A. H.

830. *Mean Luminous Intensity and Mean Illumination.* **J. Herzog** and **C. Feldmann.** (Elektrotechn. Zeitschr. 28. pp. 93–95, Jan. 31, 1907.)—The authors deal with some general photometric principles, and establish the proposition that the product of the mean illumination over any surface into the area of the surface is equal to the product of the solid angle subtended by the surface at the luminous source into the mean intensity of the source within that angle. The authors regard the decision of the Verband Deutscher Elektrotechniker to estimate the relative value of different sources in terms of the mean hemispherical intensity as a mistake. A. H.

831. *Indoor Illuminants.* **J. Swinburne.** (Elect. Rev. 59. pp. 780–782, Nov. 16, 1906. Elect. Engin. 38. pp. 695–697, Nov. 16, and pp. 730–732, Nov. 23, 1906. Elect. Rev., N.Y. 49. pp. 975–977, Dec. 15, 1906. Abstract of paper read before the Assoc. of Engineers-in-Charge.)—Deals with different methods of illumination and gives curves showing the number of c.p.-hours obtainable for 1s. from different illuminants at various prices for the same.

832. *New Form of Incandescent Lamp.* (Electrical World, 49. p. 294, Feb. 9, 1907.)—In this lamp, the invention of H. C. Parker and W. G. Clark, the light is radiated by a conducting film lining the bore of a small quartz tube. The lamp is well adapted for use where there is violent concussion from the firing of ordnance, which is destructive to the ordinary filament lamp. The heavy quartz tube of the new lamp will withstand such shocks, and a vacuum in the tube is not necessary. A. H.

833. *The "Osram" Lamp.* **Schoder.** (Zeitschr. Vereines Deutsch. Ing. 51 pp. 28–30, Jan. 5, 1907. Paper read before the Elsass-Lothringer Bezirksverein.)—The previously published results of tests on tungsten lamps are summarised and the chief curves reproduced [see Abstract No. 1286 (1906)].

834. *Incandescent Lamp Clusters and Bowls.* **J. R. Cravath** and **V. R. Lansingh.** (Electrical World, 48. pp. 1037–1041, Dec. 1, 1906.)—The light distribution from clusters fitted with various reflectors and bowls is shown graphically, the tests having been made at the Electrical Testing Laboratories of New York [see also Abstracts Nos. 528, 642 (1906)].

835. *Parabolic Mirrors with Incandescent Electric Lamps.* **G. König.** (Elektrotechn. Zeitschr. 28. pp. 47–51, Jan. 17, 1907.)—The employment of incandescent (filament and Nernst) lamps for lighthouse or searchlight purposes is considered here, from the optical standpoint, at some length. The original should be referred to as the paper does not admit of a brief abstract. L. H. W.

836. *The Tungsten Lamp.* **A. Bainville.** (Électricien, 33. pp. 185–188, March 23, 1907.)—This article contains a general summary of methods which have been proposed for the production of tungsten lamps, together with information as to mounting them in bulbs. Curves are also given showing the results of tests. [See also Abstract No. 386 (1907).] W. H. S.

TELEGRAPHY AND TELEPHONY.

837. *Keyboard Page-Printing Telegraphs.* R. Hitchcock. (Elect. Rev., N.Y. 50. pp. 870-871, June 1, 1907.)—This paper advocates the use of page-printers as opposed to the ordinary Morse. The author considers that the keyboard printer must inevitably make its way into the national telegraph service. But for very high speeds he allows that the Wheatstone's automatic possesses advantages. He would adopt electrolytic recording with this system, and eliminate mechanism in the receiver. Whether the theoretical advantages of the Rowland principle can be realised in practice remains to be clearly shown. The machines have been working for some time on the Rome-Naples line, and have apparently given the highest satisfaction. The Postal Telegraph Co. has also made an installation of Rowland apparatus. But it would seem that multiplexing introduces certain limitations in operating speed, and while it is possible to use the Rowland system in octoplex or sextuplex, the full benefit of this means of utilising conductors can only be realised in practice when it can be accomplished without reducing the speed of typewriter working. Rapid keyboard manipulation cannot be maintained if there are mechanical restrictions upon the free and independent action of the keys. The Rowland machine has such restriction in the form of a locking device, hence there is a presumption that the speed cannot equal that of ordinary typewriter practice, even when the operators become expert with the keyboard. On the Rome-Naples line, as compared with the Baudot, there is, with the Rowland system, a sweeping reduction in the cost of transmission and a virtual multiplication of the existing telegraph wires. The octoplex installation requires but six-elevenths as many operators to transmit and receive a given number of messages, and multiplies the message capacity of the wire three times. The Rowland apparatus is the outcome of years of competently directed experimental work, and even with this restriction in the speed of individual operators it ought to be thoroughly practical and efficient and capable of large extension in the regular telegraph service. Another page-printer referred to is known as the telegraphic typewriter, invented by J. E. Wright. This apparatus is of more general application than the elaborate Rowland machine. It is not costly, and can be utilised under all conditions, not requiring the facilities of a telegraph office. It can be operated on long lines, simplex or duplex, thus being adapted to general telegraph service, or it may be used locally, with a number of printers on a single wire operated simultaneously from one keyboard, thus affording an ideal means of news distribution for newspaper offices, &c. It is difficult to get satisfactory data upon which to base a conclusion as to the actual speeds of operating either the Buckingham or the Barclay printers, but whether or not the speed of either of the printers mentioned is 80 or 100 words a minute, they both show a manifest improvement over Morse working; and this is important, not only because of the increase in operating efficiency, but also in practically asserting the superiority of machine transmission over the Morse key. The Barclay machine appears to be the simpler in construction, and it is the one now favoured by the authorities; but from various considerations it would seem that the Buckingham ought to possess some superiority in speed, or at least more reliability at the highest speed than the Barclay. E. O. W.

838. *Murgas' Wave-meter for Wireless Telegraphy.* (West. Electn. 40. pp. 859–860, April 27, 1907.)—The apparatus is described and illustrated from the information disclosed in the U.S. Patent specification of J. Murgas. As in all other wave-meters, the resonance effect is made use of. Both the inductance and the capacity are made independently variable, the latter taking the form of an electrostatic telephone receiver, having a rounded metal plate, the distance of which from the diaphragm can be regulated and the position (indicating the capacity) being read off on an index at the base of the telephone receiver. The closed system is excited electrostatically (electrostatic coupling), there being two adjustable multiple-point electrodes included, which system is termed a "still discharger." The wave-length has to be calculated from the capacity and the inductance readings. L. H. W.

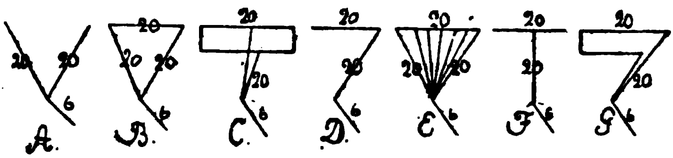
839. *Regulation of Resonance Transformers.* **A. Blondel.** (Écl. Électr. 51. pp. 217–228, May 18; 258–264, May 25, and pp. 325–334, June 8, 1907.)—In wireless telegraphy transformers are often used with condensers adjusted to resonance in their secondary circuits, and having spark-gaps across the condenser terminals. The transformers are generally of the open iron circuit type, as for example those used in the large wireless station at Nauen, near Berlin. The author shows that the adjustment for resonance can be made equally well on the primary side, and that resonance on the secondary side can also be obtained with closed iron circuit transformers, provided that choking coils with open iron circuits are put in the secondary circuit. Too much attention is generally paid by electricians to increasing the amplitude of the voltage on the secondary side, by means of resonance, as if this were the main object to be attained. The author shows that it is more important to adjust the apparatus so that the free period of the system is approximately equal to the period of the alternating current supplied. When the action of the apparatus depends on oscillatory sparks we must consider the variable state of the current system, and not merely the steady state, as every spark restarts the free oscillations. Hence formulæ which merely take the steady state into account are of little value. An oscillogram is given showing that the periodic time of the ripples in the current set up when the primary is connected with a direct-current source of supply, diminishes as their amplitude diminishes. This is due to the diminution of the permeability and of the magnitude of the losses in the core, both of which continually diminish as the magnetic state of the iron approaches saturation. This shows that the presence of iron complicates all the phenomena considerably, but in this paper these effects are neglected so as to make the formulæ of manageable length. In designing a resonance transformer it is generally the custom to fix the values of the inductances of the primary and secondary circuits, and find the value of the leakage coefficient σ, which will give the maximum secondary pressure corresponding to a given primary pressure. In this case the value of the coupling coefficient $(1-\sigma)^{1/2}$ is about 1/2, and it is generally concluded that the value of σ found in this way is the one required in practice. The problem considered, however, is not the practical one. We have no right to assume that certain variable quantities are constant. The question has to be solved in an entirely different way. We must consider that R_1, L_1, R_2, L_2 are variables (L_1 including the inductance due to the armature of the alternator), and find the arrangement that will make the damping a minimum, remembering that in practice the secondary pressure is a fixed quantity. The author obtains a first approximate solution by fixing the ratio of L_1 to R_1 and L_2 to R_2, and finding how the damping and the ratio of the

pressures varies with the tightness of the coupling. Numerous instructive oscillograms are given, showing how the oscillations depend on the distance apart of the electrodes and the nature of the circuits. When the disruptive voltage is much smaller than the maximum, we can have multiple discharges during each alternation if the period of the alternating discharge be small compared with that of the alternating current employed. When the period is of the proper length we can obtain a single discharge per alternation. We can thin out the sparks and arrange so that they only occur after appreciable intervals of time. Although it may be possible to obtain resonance it may be preferable to arrange so that "beats" occur. These phenomena are easily explained by analysing the variable state. This may be regarded as consisting of three components, the forced oscillation, one damped free oscillation and one damped disturbing term. The latter is of little importance. The frequency and the damping factor of the free oscillation depend on the constants of both the primary and secondary circuits, but in different proportions, depending on the tightness of the coupling. With a tight coupling, that is, with small magnetic leakage the phenomenon is similar to the Ferranti-effect, but when the leakage is great the influence of the primary circuit on the oscillations is of small importance. The author considers that the superiority of the open iron circuit transformer has not been established. When an open or closed iron circuit transformer is used, open iron circuit choking coils must be used in addition. A good combination is an ordinary commercial transformer with choking coils in the secondary. In this research the author came across two phenomena which require further investigation. 1. It sometimes happens that the primary circuit has itself appreciable capacity. In this case we may have two free oscillations having very different frequencies [see Wien, Phys. Soc. Abstracts, No. 586 (1897)]. This rarely occurs in practice. 2. When the adjustment for resonance is made by a gradual variation of the position of the iron core in the choking coil it is found that it is obtained quite suddenly. It is also found that the iron core can be moved over an appreciable distance without upsetting the adjustment. We have here a phenomenon due to the hysteresis of the transformer. The molecular magnets of which we may suppose the core to be made, are oscillating in synchronism with the applied forces—a necessary condition to obtain the maximum effect. To specify the action more completely wants further investigation. A. R.

840. *Recent Contributions to Electric Wave Telegraphy.* **J. A. Fleming.** (Electrician, 59. pp. 270–278, May 31; 310–312, June 7; 350–352, June 14, and pp. 378–380, June 21, 1907. Discourse delivered at the Royal Institution, May 24, 1907.)—The author gives a comprehensive *résumé* of recent work in connection with wireless telegraphy and, further, makes known some new results of his own recent experimental investigations of the Poulsen type of singing arc. It is shown, by the simple expedient of moving a neon tube rapidly to and fro in the neighbourhood of a helix in which the hitherto-assumed-continuous oscillations are set up, that the broad band of light which would be produced by persistence of vision were the oscillations really continuous, is in reality cut up by dark lines and spaces; the oscillations are, therefore, *not* continuous, but are cut up irregularly into groups of various lengths. The same effect is produced if a narrow neon tube is rotated near the helix, dark radial bands appearing in different parts in between the bright spaces. The best conditions for the production of these oscillations are stated. The use of the oscillation valve with undamped waves and as a

detector capable of giving an indication which increases with the number of trains of damped waves per sec. [see Tissot, Abstract No. 875A (1907)], is also dealt with. L. H. W.

841. *The Radio-telegraphic Aerial System.* **P. Rybkin.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 89. No. 4. Physical Part, pp. 108–114, 1907.)—The author has measured the capacity (C) of various aerial wire systems having the different forms shown in the diagrams A to G, by means of



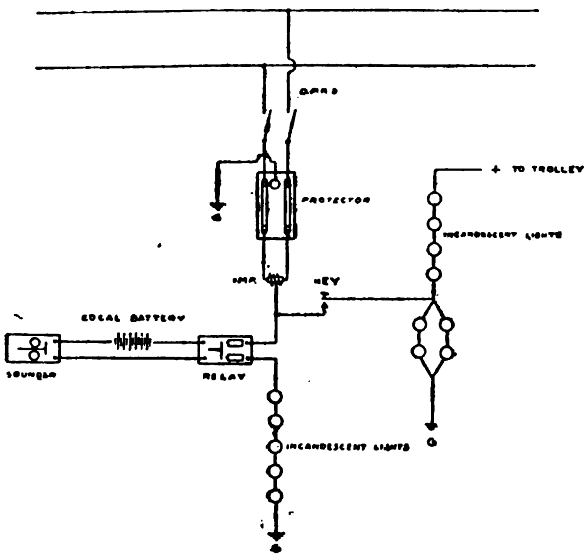
a form of differential Wheatstone bridge due to A. S. Popov. From these capacities and the wave-length (λ) he has calculated C_0, the capacity per m.; the values of the ratio $4l/\lambda$, where l = length of wire; the self-inductance (L) of the whole system, and the self-inductance (L_0) per m. These results are given in the table below for aerials made up of elements of length, 20, 80, and 40 m. :—

Length of Element.	Type of Aerial.	Capacity.	Wave-length in Metres.	Capacity per Metre.	Ratio $4l/\lambda$.	Inductance in cm.	Inductance per Metre, in cm.
20 metres	A	240	140	9·2	0·74	51,000	1,960
	B	820	195	12·8	0·58	74,800	2,860
	C	880	200	10·6	0·72	65,800	1,880
	D	250	205	5·2	0·89	109,400	2,880
	E	425	205	16·8	0·51	61,800	2,880
	F	240	195	6·7	0·74	99,000†	2,750
	G	880	220	8·8	0·84	79,605	1,780
80 metres	A	880	200	9·2	0·72	75,700	2,100
	B	440	290	12·2	0·50	119,500	8,800
	C	500	810	9·8	0·66	120,100	2,860
	D	840	800	5·2	0·88	165,400	2,500
	E	650	820	18·1	0·45	98,462	2,785
	F	885	260	6·7	0·77	126,100	2,520
	G	500	840	7·6	0·78	144,500	2,189
40 metres except C (85 m.*)	A	420	260	9·1	0·71	100,600	2,180
	B	500	815	10·9	0·58	124,000	2,690
	C	600*	870*	9·8*	0·66*	142,600*	2,840*
	D	420	890	4·9	0·88	226,800	2,606
	E	900	865	19·6	0·50	92,500	2,011
	F	420	820	6·4	0·88	152,800	2,808
	G	685	408	7·2	0·86	168,800	1,861

† Incorrectly given as 9,900 in original.

Experiments made by the author on aerial systems erected on warships give results which show, as in the case of Tissot's [Abstracts Nos. 2691 (1904), and 788 (1906)], that the aerial system which has the purest oscillations and the least damping is that one in which the value of the ratio $4l/\lambda$ is the nearest to unity. [Tissot, however, uses the inverse of the above ratio, viz., $\lambda/4l$, which latter is always > 1.] L. H. W.

342. *Combined Telegraph and Telephone System used by the Interurban Railway, Des Moines.* **E. R. Cunningham.** (Street Rly. Journ. 29. pp. 871–878, May 18, 1907.)—A metallic circuit containing 14 telephones bridged into the line has been adopted for telegraph use in the manner indicated in the diagram below; the telegraph instruments are in multiple (all stations alike). This plan has obviated the expense of an extra wire. It will be seen that condensers, which are employed when intermediate stations are in series, and which have proved troublesome to maintain, are, in the present scheme, dispensed with. The telegraph relay is cut in between the neutral point of a suitably wound impedance coil, bridged across the telephone line and grounded through about 1,000 ohms resistance. The telegraph key, which is of the open-circuit type (key without a lever switch), is cut in from some source of energy in multiple with the relay. As the 500-volt direct-current railway circuit is at each telegraph station, the key between the fourth and



fifth lamps is connected in a series of five 16-c.p. lamps to obtain about 100 volts on the telegraph line. For the fifth or ground lamp are used four 16-c.p. lamps in series multiple, which have the same resistance as one lamp; but, being in multiple, there is no danger of the ground side of the series opening and thus throwing full potential on to the telegraph line. The sounder is connected in the usual manner, either with a local battery, which in this case can be ordinary dry cells, as the sounder is on open circuit when not in use, or by shunting the ground light in a series of 5 incandescent lights in the same manner as power is obtained on the line. All telegraph instruments on the line, when connected in multiple, are connected up exactly alike, and require but one impedance coil to each telegraph station and no condensers. They are all independent of each other, and any one of them can be cut on or off the line at any time by opening the double-pole knife switch, indicated in the Fig. Another advantage of the multiple system is that it is impossible for the operator to go away and leave the line open by leaving his key open. If the series system were used it would require two impedance coils at each intermediate telegraph station and two condensers.

Another very important feature of the multiple system is the grounding of the neutral point of every impedance coil. This on lines paralleling high-tension lines serves to carry off the static charges which otherwise would accumulate on the telephone line. It is a well-known fact that both sides of the telephone line sometimes act as secondaries to the high-tension line, and that a high and dangerous accumulation of static electricity is induced on the telephone line. These impedance coils are so wound and connected that they act as impedance to the undulating voice and alternating-current telephone signalling current flowing from one side of the telephone line to the other, but do not act as impedance to current flowing from both sides of the telephone line to the ground. Therefore, the static or other stray currents of small volume but high potential can pass unimpeded from both sides of the telephone line to the ground. Since the installation of the telegraph instruments most of the above troubles have disappeared on account of the neutral point being grounded. Since it is necessary to have a well-balanced line to prevent disturbances to the telephone from high-tension and other parallel lines, the use of the telegraph on the same line as the telephone does not necessitate any further care than would be necessary for any satisfactory operating telephone line. A composite system not only doubles the amount of business that can be handled over a single line, but is much more reliable and convenient than either a telephone or telegraph line alone, because the telegraph and telephone service are not both subject to the same troubles. Although the telephone is more sensitive both to atmospheric disturbances and to induced currents from other lines, and consequently is less reliable than the telegraph, yet it is more convenient than the latter for handling a certain class of business, such as reporting cars at passing points and places where there are no operators, for reporting breakdowns or interruptions to service. E. O. W.

843. *Electric Power Cables as Telephonic Conductors.* **R. Hiecke.** (Elektrotechnik u. Maschinenbau, 25. pp. 375–377, May 19, 1907.)—The Austrian Allgemeine Co. in Vienna is making use of the conductor of the ordinary lighting or power cable, and of the test or pilot wire, to form a telephone circuit between the generating station in Obere Donau Strasse and the substation in Billroth Strasse. The length is 2,880 m., section of power cable

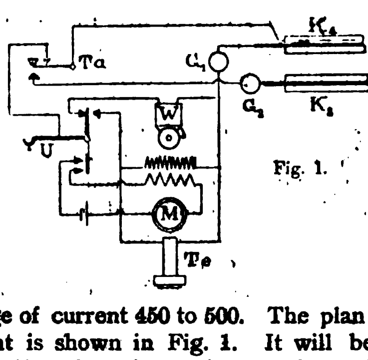


Fig. 1.

400 mm.^{2}, and voltage of current 450 to 500. The plan has been successful, and the arrangement is shown in Fig. 1. It will be observed that the 500-volt current can, if desired, be made use of for ringing purposes. G_1 and G_2 are glow-lamps inserted to form resistances. Should it be necessary to use the pilot or testing wire for its originally intended purpose, communication can still be maintained by telephone in the manner shown in

Fig. 2, which sufficiently explains itself. Investigation was made as to the best nature of core to use for the transformer T, in view to obtaining low hysteresis, and the result has been that plates of silicon-iron alloy have

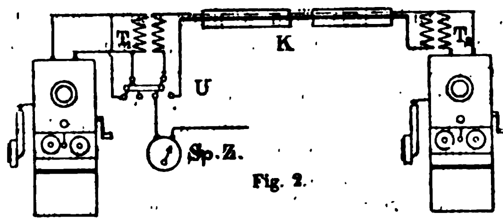


Fig. 2.

been used to build up the core. Fig. 3 shows how this material compares with iron, usually employed for transformers. Ordinates represent watts lost, abscissæ weight of material; E_1 = iron loss with ordinary iron, E_2 = loss with silicon-iron alloy, K = copper loss, G_1 = total loss with

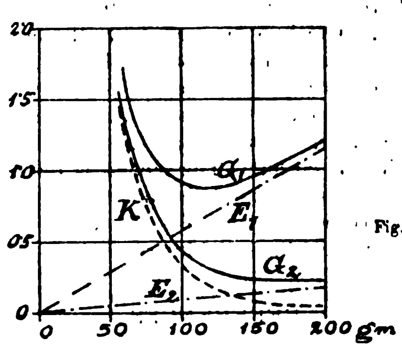


Fig. 3

ordinary iron, and G_2 with the silicon-iron alloy. In using telephones in the manner above described all the parts must be, of course, appropriately insulated. E. O. W.

844. *Resonance System of Multiplex Telephony.* **A. Maior.** (Elektrotechn. Zeitschr. 28. p. 484, May 9, 1907.)—In its simplest form, the system proposed by the author consists of the following arrangement. At the transmitting end of the line, a number of microphones, each connected in series with a self-inductance and a high-frequency source of e.m.f., are connected across the line, the frequencies of the sources of e.m.f. being all different, but all sufficiently high not to throw a receiver diaphragm into audible vibrations. At the receiving end of the line a number of telephone receivers, each connected in series with a condenser of suitable capacity, are across the line. The capacities of the condensers are so adjusted with respect to the self-inductances at the sending end and the frequencies that there is resonance between each self-inductance at one end and a certain capacity and receiver at the other. Resonance will be maintained if, when the transmitter is spoken into, the resistance of the circuit is altered; but it is evident that only one receiver will respond to any one transmitter. Poulsen's method of producing undamped electrical oscillations [Abstract No. 1620A (1905)] is suggested as a suitable one for furnishing the e.m.f.'s of different frequencies. A. H.

845. *Galvanometer for Studying Telephonic Currents.* **H. Abraham and Devaux-Charbonnel.** (Comptes Rendus, 144. pp. 1209–1211, June 3, 1907. Ind. Élect. 16. pp. 309–310, July 10, 1907.)—The difficulty of studying telephonic currents arises from their high frequency and the minute power, generally less than a microwatt, available. The alternating-current, moving-coil galvanometer previously described by H. Abraham [Abstract No. 1115A (1906)] has been found so sensitive that it can be used for the direct measurement of these currents. It can also be used to measure the e.m.f.'s developed without appreciably disturbing working conditions. The object of this paper is to show how the same apparatus can be used to measure the phase and the power in telephonic circuits as well as the amplitudes of the currents. The air-gaps of these magnetic circuit are relatively important, and the iron is only feebly magnetised. The magnetic field therefore follows rigorously in amplitude and phase the variations of the exciting current, and the instrument works as a true electrodynamometer. Hence if $I \sin \omega t$ represent the exciting current, and $i \sin (\omega t + \phi)$ the current in the moving coil, the deviation is proportional to $Ii \cos \phi$. If we now change the phase-difference of the currents by 90° the new deviation will be proportional to $Ii \sin \phi$. The two measurements therefore will give us the intensity and the phase-difference, provided that the apparatus has been standardised with direct current. Hence the problem reduces to obtaining two equal e.m.f.'s, of which one is in phase and the other in quadrature with the current. The first e.m.f. is obtained at the terminals of a non-inductive resistance in series with the circuit. The second is obtained by wrapping a few turns of well-insulated wire round the polar-pieces of the galvanometer electromagnet. This arrangement enables the authors to make an experimental research on telephonic lines and instruments. A. R.

REFERENCES.

846. *Recent Developments in Wireless Telegraphy.* **L. de Forest.** (Frank. Inst., Journ. 163. pp. 461–470, June, 1907.)—A somewhat sketchy popular *résumé*. The "Audion" is extolled and yet no mention made of its progenitor, Fleming's oscillation valve. L. H. W.

847. *Moving-coil Relay.* **J. Zelisko.** (Elektrotechnik u. Maschinenbau, 25. pp. 395–400, May 26, and pp. 419–423, June 2, 1907.)—A lengthy theoretical and experimental examination into the working conditions of a telegraphic relay designed by the author, which is of the flat-coil in two narrow air-gaps type, the movement being a transverse one and the restoring control magnetic. L. H. W.

848. *Transmitter for Wireless Telegraphy.* **J. Sahulka.** (Elektrotechnik u. Maschinenbau, 25. pp. 275–277, April 7, 1907. Écl. Électr. 51. pp. 174–175, May 4, 1907.)—The author discusses the mode of working of the device outlined in Abstract No. 225 (1907), and deals with its applicability to wireless telephony. L. H. W.

849. *Improvements in Telautographs.* **A. Korn.** (Phys. Zeitschr. 8. pp. 198–200, April 1, 1907.)—The author describes the application of the light relay (double-chord galvanometer) to his telautographic method previously described [Abstract No. 1147 (1904)].

850. *Telephone Exchange in Breslau.* **K. Langbein.** (Elektrotechn. Zeitschr. 28. pp. 289–293, March 28; 309–313, April 4, and pp. 340–344, April 11, 1907.)—A very full description, with diagrams, of a central battery exchange installed by Siemens and Halske in the year 1905. It is for 20,000 connections. E. O. W.

SCIENCE ABSTRACTS.

Section B.—ELECTRICAL ENGINEERING.

AUGUST 1907.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

851. *Recent Steam Turbine Developments.* **W. L. R. Emmet.** (West. Electn. 40. pp. 559–560; Discussion, p. 560, June 22, 1907. Abstract of paper read before the National Electric Light Assoc., June 6, 1907.)—Deals principally with the performance of a 9,000-kw. Curtis turbine unit at Chicago. The following figures give results of five tests:—

Load in Kw.	Gauge Pressure, Lbs.	Vacuum, In.	Superheat, Deg. F.	Water Rate, Lbs. per Kw.-hour.
5,874	182	29·48	188	18·15
8,070	197	29·55	116	18·0
10,186	176	29·47	147	12·9
12,108	182	29·84	148	13·05
18,900	198	29·81	140	18·6

At full load, with a 28-in. vacuum, this machine delivers to the switchboard 21 per cent. of the total energy, and 67·8 per cent. of the total available energy in the steam, and to the shaft 70 per cent. of the total available energy. This latter is compared with 75 per cent. obtained with an ideal turbine arrangement. The high vacuum obtained in above tests was produced by the base condenser having 25,000 sq. ft. of tube surface with 1-in. tubes. The gain in water-rate due to increase of vacuum from 28 to 29 in. amounts to 7 per cent. instead of the theoretical 10 per cent. Leakage losses and vibration have been greatly reduced in these recent machines. In cooling the generators with air it is said that about 90 cub. ft. rising 20° C. in temperature will carry away the heat-equivalent of about 1 kw. Replying to the *discussion*, the **Author** stated that the vacuum in the Chicago tests is corrected to 30 in. barometer. The extra consumption of steam by auxiliaries is less than 1 per cent., the exhaust being used to heat feed-water. Additional economy will result from taking live steam from the turbine with two-thirds of its latent condensation available for feed-water. A 500-kw. four-stage machine with 28-in. vacuum has a consumption of saturated steam of 19·5 lbs. per kw.-hour at full load. The coal consumption at Chicago is 1·8 lbs. coal per kw.-hour

with all stand-by losses and combustion of rather low average efficiency. The effect of superheat is practically 1 per cent. reduction in water rate for 125° superheat—this, however, is not all gain. For 150° superheat there is probably a gain of 1½ per cent. F. J. R.

852. *Results of Tests of 5,500-kw. Turbo-generator.* (Elect. Journ. 4. pp. 413–417, July, 1907. Elect. Engineering, 2. p. 258, Aug. 15, 1907.)—This generator is installed at the power-house of the Interborough Rapid Transit Co., where it runs in parallel with eight 5,000-kw. Corliss units, a special governor giving a proportionate distribution of load. The tests were to determine the variation of steam consumption with load and the variation of water rate with vacuum at a constant load. The results are fully set out in the accompanying

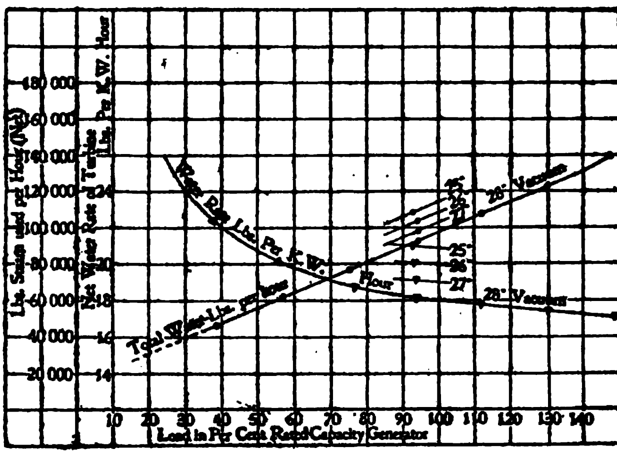


diagram and table on opposite page. A table is also given of the summary of a year's operations, showing that during 65 per cent. of the time the turbine carried an average load 2 per cent. above rating, and during December 18 per cent. above rating. The Corliss engine with 91 per cent. mechanical efficiency would have to show an equivalent water rate of 10 lbs. per i.h.p.-hour to equal the performance of turbine. F. J. R.

853. *First Rateau Generator Installed in America.* F. G. Gasche. (Power, 27. pp. 364–371, June, 1907.)—This article contains photographs and sectional plan and elevations of the installation of Rateau regenerator and low-pressure turbine and dynamos at the works of the International Harvester Co. at South Chicago, where it is attached to the main reversing 42 by 60-in. McIntosh and Hemphill steam engine of the 35-in. Blooming Mill. During a "mill cycle," or the complete mill treatment of an ingot, the engine exerts an aggregate of 11,000,000 ft. lbs. in about 200 sec., and in rolling sixteen ingots per hour the engine is practically idle for about 20 per cent. of the time. This plant requires an average of 54,400 lbs. of steam per hour with 820 h.p. distributed over the hour, or 64 lbs. of steam per i.h.p.-hour. The same amount of steam with the Rateau turbines produces 1,510 h.p. at the switchboard with a consumption of 33·6 lbs. of steam per h.p.-hour, thus making the steam-rate for the total power equal to 22·5 lbs. The steam accumulator is 11 ft. 6 in. diam. by 30 ft. long, divided by a central horizontal diaphragm into two similar compartments which have each six elliptical steam distri-

	Nominal Load—Kilowatts.							Nominal Vacuum—Inches.			
	2,000.	3,000.	4,000.	5,000.	6,000.	7,000.	8,000.	25 in.	26 in.	27 in.	28 in.
Number of tests	11	10	6	9	8	18	20	17	16	15	9
Duration (hours)	4	6	6	6	6	8	8	4	4	5	6
Throttle pressure (lbs. gauge)	152·9	152·8	152·5	152·5	149·9	149·7	151·6	149·0	150·7	152·2	152·5
Quality steam (per cent. dry)	97·16	97·87	97·80[1]	97·86	97·46	97·02	97·15	97·45	97·58	97·62	97·86
Vacuum (in.)	28·09	28·09	28·04	27·98	28·01	28·02	27·78	24·97	26·20	27·25	27·98
Barometer (in.)	29·66	29·50	30·18	29·94	30·35	30·35	29·97	29·80	30·00	30·25	29·94
Corrected vacuum (in.)	28·40	28·55	27·94	28·02	27·69	27·70	27·78	25·18	26·20	27·04	28·08
Load switchboard (kw.)	2,060	3,106	4,068	5,175	6,125	7,134·5	8,174	5,122	5,174	5,142	5,175
Wet steam per hour (lbs.)	47,578	63,624	78,468	96,149	111,882	127,082	144,210	110,330	106,155	100,267	96,149
Dry steam per hour (lbs.)	46,222	62,269	76,742	94,091	108,558	123,295	140,100	107,517	103,586	97,881	94,091
Dry steam per kw.-hour (lbs.)	22·44	20·05	18·87	18·18	17·70	17·27	17·14	20·99	20·02	19·04	18·18
Per cent. rated load	37·5	56·5	74·0	94·0	111·5	130·0	148·6	93·2	94·0	93·6	94·0

[1 47·80 in original.]

buting conduit tubes with baffle-plates, and has a capacity of 55 tons of water, sufficient by actual test to deliver all the steam for a 50 per cent. load on the turbine for 430 sec., or full load for 390 sec. Tables (too long for abstracting) are given containing full results of four tests of the 500-kw. Rateau turbine and plant and of the condenser measurement of steam from the steam engine, and an elaborate table and set of diagrams show the relation of power required by the mill at the different periods of rolling to the indicated power of the engine. Curves of consumption of steam by the turbine alone and engine and turbine combined also accompany the paper. [See also Abstracts Nos. 1008, 1120, and 1288 (1906).] F. J. R.

854. *Interchange of Heat in Steam-engine Cylinders.* **W. F. Cleveland.** (Eng. Mag. 33. pp. 605–610, July, 1907.)—The author takes the example of a steam engine running at 300 r.p.m., and argues that as the entire stroke is covered in one-tenth part of a second, there is not time for any interchange of heat between the metal and the steam. Experiments said to be analogous are quoted in support of this view of slow interchange of heat, and the author concludes that it is the water of condensation acting directly on the entering steam which is the real agent of the so-called interchange of heat losses, and that this action is greatly assisted by the free mixture of the products of compression with the entering steam. F. J. R.

855. *New Construction of Turbine Blading.* (Mech. Eng. 19. pp. 840–841, June 15, 1907.)—Belliss and Morcom, Ltd., and A. Jude have found that for maximum efficiency it is requisite that the thickness of the elementary streams should, in the successive stages of progress through a multiple-effect turbine, vary approximately with the radius of curvature of the absolute path of the stream; so that with a radius of curvature of the absolute path of the stream becoming greater, the thickness may be increased by the employment of fewer vanes, or for a continuous thickness of stream by a constant space-interval or pitch of vanes, then a uniform radius of curvature of absolute path should be maintained by the use of vanes of diminishing radius of curvature. This action is geometrically demonstrated, and a diagrammatic illustration is given of the forms of stator and rotor vanes adopted.

F. J. R.

856. *Materials for the Control of Superheated Steam.* **M. W. Kellogg.** (Amer. Soc. Mech. Engin., Proc. 28. pp. 1778–1785, June, 1907. Power, 27. pp. 485–486; Discussion, p. 486, July, 1907. Eng. News, 57. pp. 658–659, June 18, 1907.)—The author treats of piping systems, and recommends mild steel pipes with "van stone" or turned-over joint, cast or rolled steel flanges, and soft Swedish steel gasket or the McKim gasket. A sectional illustration of the "van stone" joint is given. The ordinary screwed joint is unsatisfactory, and welded branches are preferable to fittings of ordinary design. The question of metals is important because of the effect of high temperature on cast iron and on bronzes. The paper contains several practical suggestions as to joint-making and other points. F. J. R.

857. *Formulæ for the Flow of Steam in Pipes.* **G. F. Gebhardt.** (Power, 27. pp. 377–381, June, 1907.)—The author points out that the accepted formulæ have been based upon a few experiments limited to pipes of small diam., and that the application of these formulæ to larger pipes or to different conditions may lead to error. He gives the simple formula for the diam. where the steam pressure at throttle, maximum weight of steam per

unit of time and length of pipe are known, and the velocity of flow is assumed at 6,000 ft. per min., and also the hydraulic equation for the loss of head due to friction when water, steam, or gas flows through a straight pipe, and then compares nine different published formulæ for the flow of steam in pipes, and shows that they are all transpositions of the hydraulic formula except in respect to the value of f (coefficient of friction), which is taken as a constant by one group of authorities and as a function of d by another. All these formulæ are arranged in tables for the purpose of comparison, first as published, then as grouped according to the value of f, and then with respect to some concrete examples showing the drop in pressure for different velocities and diameters of pipes. Tables of O. Berner on the Flow of Superheated Steam, and by Babcock and Sickles giving results of flow of steam through various pipes are also quoted. [See Abstracts Nos. 1482, 2707 (1904), and 602 (1907).] F. J. R.

858. *Simplex Superheater.* (Engineer, 103. p. 532, May 24, 1907.)—This superheater is shown in the illustrations applied to a Lancashire boiler, and consists of a circuit of steel piping which takes steam from the top rear end of the boiler and conducts it down through the back flue and to and fro along the whole length of the bottom flue, when it ascends at the back and passes to the main steam valve at the front end of the boiler. The total length of the piping used for a 30-ft. Lancashire boiler is about 85 ft., the internal diam. being 6 to 7 in. A small branch pipe and valve also allow superheated steam to be taken to the bottom of the water space when desired. This is chiefly of use when steam is being raised. The steam can also be returned to the boiler when not wanted, and the same pipe and valve permit of saturated steam from the boiler being mixed with the superheated steam when it is being used, should it be desired to lower the degree of superheat. A test over a week, with and without the superheater in action, with a 30-ft. Lancashire boiler, showed a consumption of 21 tons of inferior coal without, and 19 tons 18 cwt. with, the superheater. The maximum total heat registered was 420° F., the temperature of the saturated steam being 298° F. F. J. R.

859. *Efficiency of Steam Boilers.* J. Batey. (Engineer, 104. p. 44, July 12, 1907.)—In a letter to the editor the author contends that the advantage gained by induced draught in some performances of Lancashire boilers referred to in a recent paper was not due to heating the air alone, but was rather the effect of the pressure conditions, a shorter grate and more fuel properly burnt per sq. ft. per unit of time, a hotter feed, &c. He also maintains that by increasing the draught pressure 1·8 lbs. above atmosphere the temperature of the fire will probably be increased 20 per cent., but does not explain how this result is reached. F. J. R.

860. *Theoretical Condenser.* R. Henderson. (Engineering, 83. p. 773, June 14, 1907.)—In a letter the author describes, and illustrates by sketches, a form of condenser devised to conform to the principles announced by R. L. Weighton [see Abstract No. 548 (1906)]. There are three nests of tubes, the first containing 52 per cent. of the total number of tubes, the second 37 per cent., and the third 11 per cent. By means of diaphragms the water is removed from each nest as formed, and the circulating water is passed by means of baffles four times through the tubes. The diaphragms are arranged to provide a gradually contracting volume for the passage of steam and air, in order to maintain as high a velocity of movement as possible. F. J. R.

861. *Properties and Use of Mineral Lubricating Oils.* **P. F. Walker.** (Eng. Mag. 33. pp. 455–465, June, 1907.)—The ordinary physical tests are not sufficient to determine the degree of excellence for lubrication: they only point out unsuitable oils. The author points out the real meaning of viscosity and the significance of the flash-point as a test of lubricants. The temperature of the film of oil in a bearing is always much in excess of that which can be measured in the metal, so that the safe limit for flashing is higher than might be supposed. 300° F. is too low for most classes of high-grade machinery. The loss of oil by evaporation is an important matter.

RESULTS OF EVAPORATION TESTS.

No. of Oil Sample.	Density at 60° F.	Flash Point.		Percentage Evaporation Loss in 30 hours at Temperatures.		
		Closed Cup.	Open Cup.	150°.	200°.	250°.
1	0·902	354°	416°	0·4	0·4	1·0
2	0·867	340°	372°	0·4	0·6	2·2
3	0·872	272°	290°	3·2	12·4	24·2

These results are graphically recorded, as are also viscosity tests on several oils, and the coefficients of friction of these same oils, and the latter show that at high pressures differences in viscosity are not sufficient to account for the marked differences in friction. The lubricating properties of oil are more properly considered as properties of films than of masses of oil of considerable thickness, but these properties have been little investigated. Both viscosity and the tensile strength of the film require investigation. Rayleigh's investigation on "superficial tension" or "surface tension" of liquids are of value in this direction, but much remains to be done with films in order to explain many of the phenomena observed. [See also Abstracts Nos. 885, 1849 (1905), 921, 1888 (1906).] F. J. R.

862. *Kermode's Liquid Fuel System.* (Engineering, 84. pp. 74–76, July 19, 1907.)—This article illustrates and describes the application of this system to two Babcock-Wilcox boilers at Toula Brass-Rolling and Cartridge Works, St. Petersburg. The boilers have each 1,829 sq. ft. heating surface, and with oil of 19,400 B.Th.U. theoretical heat value per lb. and an air pressure of 0·7 lb. per sq. in., gave an evaporation of 13·82 lbs. of water per lb. of oil fuel used —the temperature of the feed being 64·4° F., and the working steam pressure 100 lbs. per sq. in. The heat efficiency is 79·65 per cent. of the theoretical value of the oil used. A section of the burner is given in the illustrations, which should be consulted for the details of the arrangement. F. J. R.

863. *Peat-coke Manufacture in Bavaria.* (Elektrotechnik u. Maschinenbau, 25. pp. 400–402, May 26, 1907.)—The article describes the Ziegler method [see Abstract No. 1886 (1904)]. The Aktiengesellschaft Oberbayerische Kokswerke u. Fabrik Chemischer Produkte has been formed to exploit the Ziegler patents for peat-coke manufacture, and a coke and chemical works using this method has been erected at Beuerberg, in Bavaria. The works comprises two engine-houses, a building containing four peat-retorts, a tar-water

and tar distillery, a paraffin oil factory and reservoir, and the sorting and storing-houses for dealing with the coke and other products. The works obtains the peat from a bog situated close to the factory. The peat is cut by machines, and is conveyed to the retort-house by a light railway, after pressing in Ziegler presses, and being left exposed to the air until the water content has been reduced to under 25 per cent. Peat containing over 25 per cent. of moisture cannot be coked in the Ziegler retort. The peat-cutters and presses are worked by electric motors, this being one of the first peat-works to use electricity in place of steam for operating this portion of the plant. The retorts are charged from above with the air-dried peat, a charge remaining in the retort 18 hours and the coke being received in air-tight iron barrows, which are covered and left 6 to 8 hours to cool before discharging. Each retort yields 8 to 10 tons of coke of the following percentage composition per 24 hours: Carbon, 87·8; ash, 8·2; hydrogen, 2; nitrogen, 1·8; oxygen, 5 per cent.: calorific value, 7,800 kg.-cals. The gas produced contains in per cent. 27·4 CO_2; 8·6 CO; 14·80 CH_4, and possesses a thermal value of 2,700 kg.-cals. This gas is employed for assisting the retort process, which, owing to the large amount of moisture present in the air-dried peat, could not continue or even commence without the aid of external heating. Before being used for this purpose, however, the gas is passed through several evaporating and cooling tanks and towers, in which the by-products are separated. J. B. C. K.

GAS AND OIL ENGINES.

864. *Modern Aims and Results of German Heat Engine Design.* **H. Dubbel.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 765–769, May 18; 845–854, June 1, and pp. 901–908, June 8, 1907. Amplification of paper read before the Aachen Section.)—The first part, dealing with steam engines, is only a short survey of recent tendencies. In the second part the gas engine is more fully considered. Under blast-furnace gas operation the author refers to the chief desiderata: purity, dryness, moderate temperature, and not too great variation in the calorific value of the gas. Cleaning of the gases down to a dust content of 20–80 mgm. per $m.^3$ is now carried out, for which purpose 1·5–2 per cent. of the total output is needed. But with this degree of purity the engines can work for 6 months without cleaning (except valves). The cleaning water can be reduced to a minimum by the use of Junkers' surface condensers (illustrated), which reduce the temperature of the mixture. Tests of Oechelhäuser engines have shown that an increase of output of 17 per cent. is obtainable by this means. Variation in calorimetric value, usually within 10–20 per cent., are best avoided by the use of large gas-holders. The design of cylinders and valve gear and the regulation question are then considered. Scavenging of the cylinders has lately been carried out even in 4-stroke engines; a greater output is obtained if the gas mixture is used in place of air alone. This entails the use of two pumps, of which the air-pump takes about 2–8 per cent. of the engine's output. The simplicity of the water-cooling arrangement for the piston-rod, devised by the Maschinenfabrik G. Luther, of Brunswick, is referred to, with illustration, as also the water-cooled piston of Schüchtermann and Kremer. Reference is made to results with small gas engines. A test by J. Pintsch of a 8-h.p. Güldner engine intended for train-lighting purposes at 550 r.p.m. and an output of 5½ b.h.p., showed a consumption of 290 litres of oil-gas—that is, 2,820 kg.-cals.

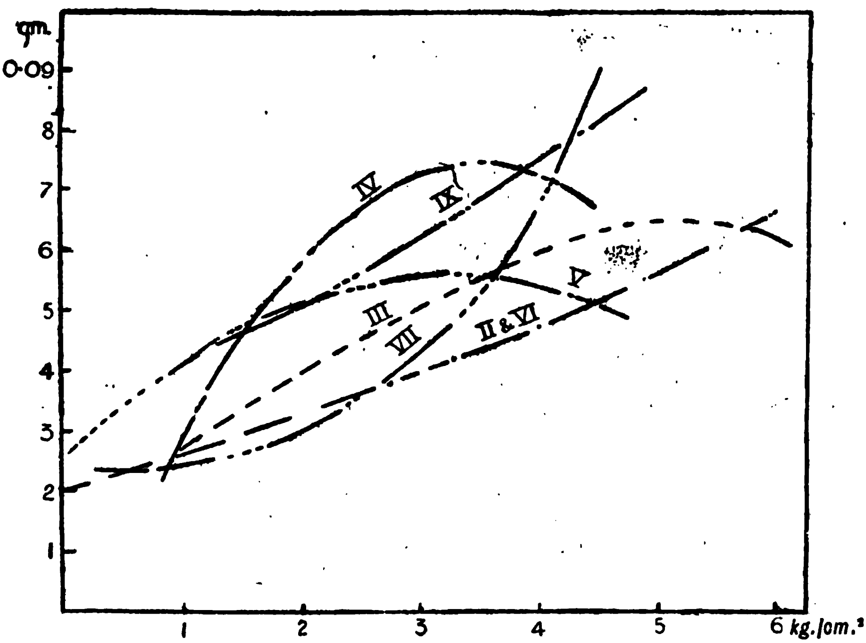
per b.h.p.-hour. In the case of liquid-fuel engines E. Meyer's tests on a Trinkler (with separate air-compression) engine of 12 h.p. are pointed out, in which a consumption of 221 gm. of Russian crude naphtha per b.h.p.-hour was obtained (2,180 kg.-cals. per b.h.p.-hour) and a thermal efficiency of 29·2 per cent. found. The consumption at half load was 288 gm. L. H. W.

865. *Working Experiences with Large Gas Engines.* **C. A. St. G. Moore.** (Mech. Eng. 19. pp. 845–848, June 15, and pp. 870–873, June 22, 1907. Paper read before the Soc. of Engineers, June 3, 1907. Elect. Engin. 39. pp. 801–803, June 7, and pp. 827–830, June 14, 1907.)—This paper deals principally with defects experienced in some Körting engines extending over a period of about two years, these comprising chiefly defects in pistons of different methods of construction, cracking of cylinders, wear of cylinders, cambering of piston-rods, and packing of piston-rods. Stratification of gaseous mixtures is discussed, and correct timing of ignition is illustrated by indicator diagrams. Several diagrams also illustrate pre-ignition taking place at different points, and the causes of these pre-ignitions are minutely discussed. The author maintains that no installation of large gas engines is complete without means for the utilisation of the heat carried away by the exhaust, and advocates the use of a boiler to raise steam for producers, the steam being superheated in a chamber surrounding the exhaust pipe between engine and boiler. The paper concludes with some remarks on gas from pressure producers, dealing specially with the persistence of tar in the gases and the absolute need of cooling down to atmospheric temperature. Experiments showed no tendency to pre-ignition in large engines with increasing calorific value of producer gas from 140 to 165 B.Th.U. per cub. ft. When, however, the load on the engine with a pressure producer-plant is suddenly largely reduced, gas of a high value continues to be yielded for a time, and careful manipulation of the stop valve is required. F. J. R.

866. *F.I.A.T. Reversible Internal Combustion Engine.* (Mech. Eng. 19. pp. 907–908, June 29, 1907.)—Describes and illustrates mechanism, patented by the Fabbrica Italiana Automobili of Turin, for reversing the direction of rotation of internal-combustion engines without the risk of their coming to a standstill when reversed. As illustrated by partial elevation and sections the cam-shaft, carrying broad cams each with two swells, can be moved horizontally in its bearings by a suitable lever. This shaft also carries a helical wheel, gearing with another wheel the shaft of which carries a revolving distributing valve in a chamber connected by tubes with the various motor cylinders and with a compressed-air pipe. There are holes in this valve corresponding with the openings to the tubes, one of which is uncovered at a time as the valve revolves. By means of suitable valves the connection between the distributing chamber and the proper cylinder is at once opened when the engine is reversed, and the compressed air becomes the motive force as when starting the engine at first. Retaining valves prevent the pressure in any cylinder being communicated to the distributing chamber should this be necessary at any moment. F. J. R.

867. *Tests of Internal Combustion Engines for Automobiles.* **Fehrmann.** (Verein z. Beförd. des Gewerbfleisses, Verh. No. 4. Report (as Supplement) of meeting of April 8, pp. 107–198; Discussion, pp. 198–200, April, 1907.)—The measurements carried out were for the purpose of determining (1) the

efficiency of the transmission gear of automobiles of different construction, and particularly of heavy transport vehicles, and (2) the possibility of using benzol and alcohol, as well as mixtures of these two fuels or with petrol, in the engines of such vehicles. The vehicles and engines taken for the tests were as follows: Cars I. and II. were almost identical, 28-h.p. 4-cylinder, of the live-axle type. Cylinders 110 mm. bore by 140 mm. stroke, 800 r.p.m. Motors I. to III. were identical; I. and III. meant for petrol, II. for alcohol also; magneto break-spark ignition; all valves mechanically operated. Cars IV. and V. were of the same make and identical; their engines were 2-cylinder ones; cylinders 140 × 170 mm., 650 r.p.m. The transmission was by cross-shaft and side chains; ignition as above. Car VI. had a single-cylinder horizontal engine, driving, without change of plane, long chains on



the rear wheels; cylinder 250 × 250 mm., 400 r.p.m., 24 h.p.; ignition as above. Car VII. had a single-cylinder (110 × 120 mm.) engine, 1,000 r.p.m., 4–5 h.p.; ignition as above; automatic inlet-valve; friction drive. Car VIII. was a front-wheel-driven car, having a 2-cylinder (110 × 130 mm.) engine, 850 r.p.m., 10–12 h.p.; ignition by coil and sparking plug; all valves mechanically operated. Motor IX. was a single-cylinder (100 × 120) engine of the two-stroke-cycle type, 3–4 h.p. at 750 r.p.m.; coil ignition. The tests comprised brake tests on the motor itself, on the transmission shaft, and on the road wheels themselves when this was possible. The results as to fuel consumption are set out in tables, which should be referred to, the piston speed and mean pressure being given, the b.h.p. and the revs. for each of the speeds of the gear-box, for the different fuels. Indicator diagrams taken with a Maihak indicator are reproduced. It is impossible to deal briefly with the separate results, but in comparing the output and thermal efficiency of the different engines the Fig. here reproduced is given, showing in an interesting way that Motors II. and III., though of identical manufacture, manifest con-

siderable difference in their behaviour. Piston pressures in kg./cm.[2] are plotted as ordinates, and the petrol consumption per 1 litre of cylinder capacity as abscissæ. (In IX. the mean pressure referred to 2 revs.) A slow rise in fuel consumption with increasing load is only shown by Motors II. and VI. Motor VII. shows the most rapid rise in fuel consumption at the higher loads, which can be attributed to the automatic inlet valve. In the experiments on starting the engines it was found that with alcohol alone none of the engines could be started when in the cold state. The author gives the following summary of the results of the investigation. (1) Those engines which have an arrangement by which the air can be sufficiently preheated, and in which it is arranged that a proper mixture ratio of air and fuel is obtained, give with petrol, benzol, and alcohol almost equal maximum outputs. In engines with insufficient gasification the max. output with benzol is 4 to 8 per cent. smaller, and with alcohol 16 to 19 per cent. smaller, than the max. output with petrol as fuel. For mixtures of benzol and alcohol intermediate values are obtained. (2) So far as the thermal efficiency is concerned, petrol and benzol behaved similarly at all loads. With alcohol, at the higher loads, much more favourable results were obtained than with petrol and benzol; but at lower loads sometimes a lower efficiency was noted. (3) The 4-stroke engines, so far as they were tested on this point, operated with a distinct deficiency of air, the 2-stroke engine with apparent excess of air; but in spite of this the latter secured no better combustion than the 4-stroke engines with deficiency of air. (4) The differences in the thermal efficiency of the separate fuels can be ascribed in all probability to departures from the correct ratio between air and fuel. (5) The, in some cases, greater outputs of engines when operated with petrol and benzol as compared with alcohol, are due to the generally observed higher fuel-charge carried by mixtures of air with the first two fuels, a sufficient combustibility being assumed in all cases. (6) Besides, its ability to stand low temperatures, benzol presents no difficulty, as a fuel, for fast-running automobiles, except as regards starting, so long as an approximately correct mixture ratio is preserved. With any considerable deficiency of air, however, difficulties soon arise. It is interesting to note that the exhaust gases generally show a larger percentage of CO_2 with benzol and alcohol than petrol, but a much-reduced percentage of CO, especially in the case of alcohol. L. H. W.

AUTOMOBILISM.[1]

868. *The Steam Motor Car in Interurban Service.* **W. G. Wagenhals.** (Street Rly. Journ. 29. pp. 698–699, April 20, 1907. Paper read before the Iowa Street and Interurban Rly. Assoc.)—Chiefly taken up with a description of the Wagenhals steam motor car. The car has a larger tractive effort than the largest American 6-wheeled locomotives. Of length 82½ ft., and with a seating capacity of 64, the weight on driving wheels is 115,600 lbs., and on rear truck 62,960 lbs.; total 178,560 lbs. It can haul two trailers at 45 m.p.h. up ½ to 1 per cent. grades. The boiler is oil-fired and works at 800 lbs. pressure, and enough fuel and water is carried for a 500-mile run. The engine will develop 275 h.p. at the rail. Repeated tests have shown a fuel oil consumption of 2 galls. per mile. L. H. W.

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

869. *Traction Wheel with Sinusoidal Tread.* (Scientific American, 97. p. 24, July 18, 1907.)—The wheel illustrated in this article is due to B. Beskow, and differs from ordinary wheels in that the tread, while perfectly circular and concentric with the axle, is, when viewed in a direction at right angles to the axle, of sinusoidal form. Each wheel is made up of a pair of such sinusoidal treads made opposite in the two wheels, so that no resultant side displacement occurs. Each double wheel is built up of two elliptical steel plates bent along their minor axes, their edges being bent over and telescoping with one another, thus forming the tread. Special qualities are claimed for such wheels, among which the impossibility of becoming clogged with mud, the great tractive power—even in deep, loose sand—and the tendency of the sinusoidal tread to gradually carry any obstacle to the side, may be mentioned.

L. H. W.

870. *Aërial Navigation.* **B. F. S. Baden-Powell.** (Soc. Arts, Journ. 55. pp. 596–601; Discussion, pp. 601–605, April 19, 1907.)—A brief review of the subject. The following table is given, summarising the chief data relating to recent aeroplane machines and their performances :—

	Span.	Area.	Total weight with operator.	Engine.	Propeller. Diam.	Propeller. Revs. per min.	Speed attained. On ground.	Speed attained. In air.
	ft.	sq. ft.	lbs.	h.p.	ft.		Miles per hour.	Miles per hour.
Wright	40	480	925	24	2	—	—	38–40
S. Dumont (1)	39	560	550	50	6	1,000	24½	22–26
„ (2)	36½	146	500	50	6½	—	25	—
Bleriot	25½	140	600(?)	24	5¼	—	—	—
Delagrange	32·0	645	638	50	6·9	1,500	—	15
Vuia	—	215	605	—	7¼	—	—	—

L. H. W.

REFERENCES.

871. *The Gas Turbine.* **G. Belluzzo.** (Atti dell' Assoc. Elettr. Ital. 11. pp. 190–210, May–June, 1907. Elettricità, Milan, 27. pp. 315–319, May 24, 1907.)—A general discussion of the problem with illustrations of and references to the turbines of Stolze and of Armengaud, and to the paper of Deschamps. A brief account of some unpublished experiments is given. L. H. W.

872. *Turbine Theory.* **W. Hort.** (Zeitschr. ges. Turbinenwesen, 4. pp. 277–280, June 28, 1907.)—A mathematical discussion of the transverse vibration of turbine axes due to the eccentricity of the turbine wheel. Expressions are obtained for the critical speed. A. W.

873. *Simmance and Abady Combined CO_2 and Draught Recorder.* (Electrical Times, 32. pp. 30–31, July 4, 1907.)—This apparatus depends upon the absorption of CO_2 from a measured volume of the boiler or furnace gases by a solution of caustic potash, and the measurement of the residual gas under constant conditions of temperature and pressure. The description requires the accompanying illustrations. J. B. C. K.

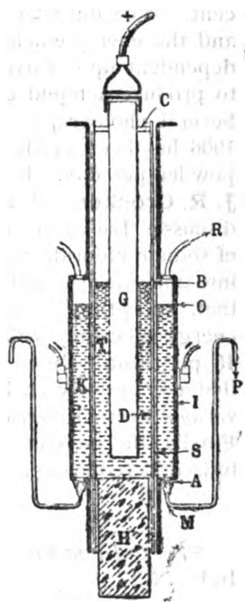
INDUSTRIAL ELECTRO-CHEMISTRY, GENERAL ELECTRICAL ENGINEERING, AND PROPERTIES AND TREATMENT OF MATERIALS.

874. *The "Delef" Element.* **Wiechmann.** (Elektrochem. Zeitschr. 14. pp. 69–74, July, 1907.)—The electrodes are zinc and copper oxide in caustic soda, the black copper oxide being by a secret process obtained in firm, glass-hard, finely porous plates of large surface, which, when reduced, become quickly re-oxidised on exposure to air. The cells are sealed, and made in two sizes—the small size for 60 amp.-hours containing 1 zinc electrode of 80 gm. weight and 100 gm. of powdered caustic, which is supplied in capsules; the large size, for 1,000 amp.-hours, contains 5 zincs weighing 1,400 gm., and 2 kg. of caustic soda in solution. H. B.

875. *Electrolysis of Gold from Cyanide Solutions.* **D. Lay.** (Eng. and Mining Journ. 83. pp. 801–803, April 27, 1907. Metallurgie, 4. pp. 500–502, July 22, 1907.)—The author introduced precipitation on the Siemens and Halske system at the Reliance Mill, Nelson, B.C., which was closed last winter. 150 tons of solution passed daily through three tanks, coupled in parallel, each 35 ft. long, 5 ft. wide, 3 ft. deep, and containing 3,500 sq. ft. of kathode surface. The KCN percentage was 0·01. The anodes of iron were fitted into saw-cuts, provided alternately in the sides and in the bottom of the tank walls; in the former case the plates were 1·5 in. above the bottom of the tank and projected out of the lye. The anodes were 3 in. apart, covered with cheese-cloth, and all in parallel. The positive main ran along one of the sides, and lead plugs in the wood established connection with the anodes, which corroded; the rising ferric hydrate was carried over an overflow lip. When free alkali, 0·08 per cent. of lime, was added to the bath, there was hardly any destruction of cyanide and little formation of Prussian blue. The kathodes were sheets of lead, weighing 7 lbs. each, suspended from iron rods; these sheets were supplied by the smelting works at Trail, which took the kathodes with their deposits of silver and gold back. The current strength was kept low as the solution of noble metals was very dilute. The author gives an empirical formula as to the relation between the flow of the solution through the tanks, in tons per hour, and the kathode surface; he electrolysed at 70° F. by currents varying from 0·02 to 3·09 amp. per sq. ft. of kathode surface. H. B.

876. *Townsend Cell for Sodium Chloride Electrolysis at Niagara Falls.* **L. H. Baekeland.** (Soc. Chem. Ind., Journ. 26. pp. 746–749, July 15, 1907. Paper read before the New York Section. Electrochem. Ind., N.Y. 5. pp. 209–212, June, 1907. Abstract.)—The paper commences with the effects due to recombination of the alkali hydrate and nascent chlorine, which, producing hypochlorites and chlorates, involve a waste of energy and lead on decomposition to a disintegration of the carbon anodes. Many inventors have given insufficient attention to the following principles: (1) The rate of diffusion between anolyte and katholyte, which is a function of the concentration of the diffusion solutions; (2) the amount of diffusion, which is a function of the time during which the given solutions remain in contact;

and (3) the fact that the alkaline hydroxide in contact with the kathode takes part in the electrolysis and tends to migrate towards the anode, where it has an oxidising action. For these reasons many electrolysers with a good amp.-hour efficiency give a weak caustic liquor. The author regards as retrograde those methods in which the liberated sodium hydrate is submitted to the action of CO_2 and transformed into carbonates, whose market value is lower. The appended diagram illustrates a vertical cross-section of the Townsend cell, which is designed to counteract diffusion and recombination by subtracting every drop of kathode liquor as soon as it appears, by surrounding it with kerosene. The anode space is enclosed between a lid (C), two vertical diaphragms (D), a non-conducting body (H) having the shape of a wide U (and of which only the section of the lower part is to be seen in the diagram); graphite anodes (G) pass through the lid of the cell and the protruding tops are connected by means of clamps to the electric generator; the diaphragms are in close contact with perforated iron kathode plates (S). The latter are fastened to two iron sides (I), bulging towards the middle, which form what is called the kathode compartment. The anode space contains saturated brine (T), while the kathode compartment contains kerosene oil (K). On account of the difference in sp. gr. between the two liquids there is a hydrostatic pressure from the anode compartment toward the kathode compartment. Even if the level of the two liquids be the same there is a tendency of the brine in the anode compartment to press through the diaphragm and flow into the kerosene. If the electric current be turned on the percolating brine becomes kathode liquid and carries caustic hydrate. The strength of the caustic hydrate will increase according to the number of amps. which are sent through the cell. Each drop of liquid, as soon as it traverses the diaphragm, runs through the perforations of the anode plate and acquires a globular shape, by a capillary phenomenon, produced on contact with the kerosene oil. This provokes a rapid separation of the aqueous liquid, so that every drop as soon as it forms detaches itself rapidly, sinks to the bottom of the oil, and accumulates in a small caustic pocket (A). This puts it entirely outside of the zone of possible chemical or physical action. A goose-neck tube (P) drains this liquid from the supernatant oil, and thereby avoids its accumulation beyond desirable quantities. The inflow and overflow of the brine in the anode compartment are so regulated as to maintain a steady level. By a simple contrivance this level can be increased or decreased at will, thus controlling the hydrostatic pressure in the inside of the anode compartment. This gives a simple means of increasing the rate of percolation, and thereby producing stronger or weaker caustic liquor, in accordance with the current density. These cells are now in operation in sizes working at 2,000 and 2,800 amps. and cells working at 4,000 amps. are now under construction. The current density is about 1 amp. per sq. in. of anode surface. The latest forms of diaphragm used are those patented by Baekeland, and consist of a woven sheet of asbestos cloth, of which the pores are filled with a special mixture of oxide of iron,



asbestos fibre, and colloidal iron hydroxide. The latter material produces a sort of binder for the asbestos fibre and the oxide of iron; its function is somewhat similar to that of rosin or glue size in the manufacture of asbestos paper, but it has a great advantage over organic sizes in that it does not become gummy in contact with sodium hydrate. The mixture is applied with a brush and painted on as ordinary paint. Whenever a diaphragm has to be renovated the surface is simply scrubbed and washed with water; a new coat of paint is applied, and after this is dry the diaphragm is again ready for use. This process has only to be repeated at long intervals, and requires but a few minutes. A diaphragm may not require repainting for several months. Under favourable conditions current efficiencies of just on 100 per cent., with an e.m.f. of 3·4 to 3·6 volts may be obtained. During six months the current efficiency seldom fell below 90 per cent. Working 0·25 amp. per sq. in. the current efficiency is 93 per cent., and the energy efficiency 55 per cent. The density of the caustic liquor is dependent upon current density and percolation. It is found advantageous to produce a liquid containing 150 gm. NaOH and 218 gm. NaCl per litre. Several photographs are given of the installation at Niagara, which since 1906 has been producing 5 tons of caustic soda and 11 tons of bleaching powder per day. It is stated that its capacity is to be increased fourfold. **J. R. Crocker.** (Electrochem. Ind., N.Y. 5. p. 258, July, 1907.)—Crocker discusses Baekeland's paper. He points out that for aqueous solutions of sodium chloride the theoretical voltage necessary to effect decomposition into chlorine gas and sodium hydrate is 2·29. The author, therefore, urges that, accepting Baekeland's statement as to high current-efficiency, the energy efficiency with 5 volts p.d. across the electrodes would be about 45 per cent. Upon the subject of amp.-hour efficiency, it is suggested that average efficiencies of 90 per cent. are exceptional. The output under various current densities is asked for as bearing upon the heat wastes. Finally, the amount of salt percolating through the diaphragms is characterised as requiring a considerable amount of work in the vacuum pans.

W. P. D.

877. *Calcium-Zinc Alloy by Electrolysis.* (U.S. Pat. 856,075. Electrochem. Ind., N.Y. 5. pp. 279–280, July, 1907.)—F. v. Kügelgen and G. O. Seward electrolyse molten $CaCl_2$ with a kathode of molten zinc in a cell of cast iron whose bottom is joined to the negative terminal. The two metals alloy in almost any proportion, and the alloys remain at the bottom of the cell. In order to prevent any metallic deposit on the side of the vessel, where the alloy would be attacked by the chlorine liberated, the sides are cooled and thus coated with a layer of solidified salt. The alloys are brittle, can easily be powdered, and are recommended as reducing agents in the place of Al and Ca.

H. B.

878. *Silicon as Reducing Agent for producing Metals and Alloys from Sulphides.* (U.S. Pat. 855,157. Electrochem. Ind., N.Y. 5. pp. 287–288, June, 1907.)—This process, F. M. Becket's patent, is said to be applicable to sulphide ores, concentrates, matte, &c., in general, but has particular advantages for the reduction of Mo and V from their sulphide ores. Commercially pure Fe-Mo, Fe-V, Ni-Mo, or Ni-V may be produced by smelting in an electric furnace a mixture of Mo or V sulphide with ferro-silicon or nickel-silicon, preferably in such proportions as to supply sufficient Si to unite with the S of the sulphide. This last condition is not essential,

however, the amount of Si alloy being varied according to the proportion of Si permissible in the product. Operating in a closed furnace, SiS_2 may be recovered; in open furnace, SO_2 and finely-divided SiO_2 are the by-products.
F. R.

879. *Electric Steel Furnaces.* **J. Saconey.** (Bull. Soc. de l'Industrie Minérale, No. 2. p. 441, 1907. Stahl u. Eisen, 27. pp. 954–957, July 8, 1907.)—An abstract by Eichoff of the report made by Saconey and other experts on behalf of an Italian Company, upon the working of the Stassano furnace at Turin, of the Héroult furnace at Remscheid in Germany, and of the Girod furnace at Ugine. Five charges were worked in the *Stassano* furnace in presence of the experts. The furnace and process are stated to be worthless for the production of steel direct from the ore, but it has a field of utility in the manufacture of special steels and alloys from pig-iron and steel scrap. Since the temperature attained in the Stassano furnace is comparatively low, it is not possible to eliminate the sulphur and phosphorus from the raw materials of the ore. As regards the *Héroult* process and furnace, the claim made by the patentee that the impurities of the raw materials can be eliminated, was substantiated. The method adopted for regulating the two electrodes by hand during the first heating of the charge, however, is condemned, and objections are raised to the use of two electrodes in series. The power consumption for this furnace and process was stated to be 600 kw.-hours per ton with molten iron, and from 1,200 to 1,400 kw.-hours per ton with cold pig and scrap as raw materials. The *Girod* furnace was of the cylindrical type with the upper electrode 300 mm. square. The power consumption was 800 kw.-hours per ton of steel with cold materials. Comparing the three furnaces and processes, the report states that the Girod furnace is the best of the three named above, since it raises the metal to a higher temperature than the Stassano furnace and avoids, by the use of one electrode in place of two in series, on the other hand, some of the difficulties attaching specially to the Héroult furnace and process. A running comment is made by Eichoff upon the opinions expressed in this report, with the greater number of which he is in direct conflict.
J. B. C. K.

880. *Low Carbon Ferro-alloys.* (U.S. Pat. 852,847. Electrochem. Ind., N.Y. 5. pp. 278–279, July, 1907.)—In order to gain high-grade ferro-chromiums and other ferro-alloys, E. F. Price first makes ferro-silicon, high in Si and low in C, by smelting by alternating currents finely-ground silica, iron ore, and coke in a furnace which is lined with carborundum, siloxicon, or carbon. The hearth of carbon is the one electrode, a suspended carbon rod the other. The ferro-silicon is tapped off into the second, lower furnace, which is lined with chromite or magnesia and provided with a metal casing; the two electrodes for the alternating currents are both suspended. The furnace is charged, *e.g.*, with chromite and lime. The silicon reduces the Cr which combines with the iron, while a silicate slag is formed. The latter having been drawn off, more ferro-silicon is run out of the first furnace. [Compare Abstract No. 209 (1906).]
H. B.

881. *Colby Induction Furnace.* (Electrochem. Ind., N.Y. 5. p. 282, June, 1907.)—A description of the Colby furnace at the saw-works of H. Disston Sons, Tacony. This furnace is rated at 181 kilovolt-amps. The voltage of

the single-phase primary current is 240 and the frequency 60. The primary consists of 28 turns of copper tube, ⅜-in. inside and ⅝-in. outside diam., and is cooled by internal water circulation. The annular crucible which, with its contents, forms the secondary of the transformer furnace, is a one-piece crucible, 14¾ in. inside and 24¼ in. outside diam., 8 in. in height. The trough is 6⅝ in. deep, $2\frac{7}{16}$ in. wide at top, and 2 in. at the bottom, with a working capacity of 190 lbs. of steel. The current in this crucible is, at a maximum, 15,148 amps. at 8·57 volts. Ingots of 90 lbs. can be poured every hour, leaving 100 lbs. in the crucible. Fresh materials are then added at once. The fusion is complete in 80 min. The current used per 100 lbs. of metal poured is stated to vary between 27·5 and 87·5 kw.-hours, according to the nature of the charge and the percentage of carbon desired in the finished product. W. P. D.

882. *Iron Alloys for Magnetic Purposes.* (Brit. Pat. 11,974 of 1907. Engineer, 104. p. 26, July 5, 1907. Abstract.)—R. A. Hadfield claims the use of from about 0·25 to 8 per cent. Si, Al, or P, or two or all of these substances in iron otherwise as pure as possible—*e.g.*, Swedish. The qualities of the material are enhanced by heat treatment, *e.g.*, cooling slowly (10° per hour) from 1,050° C.; or, cooling quickly, from 950°, and reheating to 750°, followed by very slow cooling. F. R.

883. *Copper Castings.* (Electrician, 59. p. 468, July 5, 1907. From Electrical Rly. Rev.)—Recommends the use of about ⅛ per cent. Mg in making sound copper castings of high electrical conductivity. It should be added in the form of a 10 per cent. Mg alloy with copper, separately prepared by melting under charcoal. F. R.

884. *New Combined Solder and Flux (Tinol).* **M. Corsepius.** (Verein z. Beförd. des Gewerbfleisses, Verh. No. 5. pp. 287–244, 1906.)—In this report the conductivity and strength of joints made with the new composition is investigated, full details of the tests being given. Tinol, as the solder is called, consists of a tin and lead soft solder, which is then reduced to a very fine powder and mixed with dry powdered fluxes. It is next worked up to a paste or thick viscous fluid with glycerine, alcohol, &c. When soldering is to be carried out, the paste is spread over the joint and the latter warmed, or a hot soldering iron passed over it. The strength of joint is equal to, and the conductivity 4 to 5 per cent. higher with Tinol than, that of joints made by ordinary soldering methods. L. H. W.

885. *Flux for Soldering Cast Iron.* (U.S. Pat. 852,017. Electrochem. Ind., N.Y. 5. pp. 283–284, July, 1907.)—C. Ellis claims finely-divided iron as an essential constituent of a flux for soldering cast iron. A suitable composition for general purposes is a mixture of fused borax, pulverised, 12 lbs., chemically pure finely-divided iron 40 lbs., chemically pure potassium carbonate 9 lbs. This is made to a thick paste with water, and applied to the surfaces to be joined, which are then pressed together and heated to low red. The solder is then run in with plenty of anhydrous borax. The finely-divided iron may be produced by the reduction of oxalate in hydrogen. F. R.

886. *Electric Welding Improvements.* (Elektrotechnik u. Maschinenbau, 25. pp. 508–509, June 30, 1907.)—An electric welding machine, designed by

the Fabrik Elektrischer Schweissungen, of Szepesváralja, Hungary (Austrian Pat. 25,940), for welding chain links, rings, &c., made from wire wound upon a mandrel and cut longitudinally, is provided with a device for bringing the ends of the link exactly opposite each other before welding. The portion of the link opposite to the proposed weld is gripped in a bracket, and the electrodes, which grasp the ends to be welded, are movable vertically in opposite directions. An alternative method is to make the electrodes stationary and to cause the bracket holding the link to revolve through an angle sufficient to bring the ends opposite each other. H. Helberger, of Munich, has patented an electric welding machine (D.R. Pat. 169,641), for making lap welds, in which, during heating, mechanical pressure is exerted by a roller or similar device, and at the same time an automatic hammer, striking the said pressure device, produces intimate contact of the lap, and a thoroughly solid weld is obtained. The Thomson process of electric welding is employed. [See also Abstract 814 (1906).] An improved clamp for welding rods of irregular polygonal section, introduced by the A.E.-G., of Berlin, (D.R.-P. 171,092), is so designed as to overcome the difficulty of uneven heating owing to the thinner portions cooling more rapidly than the thicker portions by reason of the former offering a relatively greater radiating surface than the latter. The clamp is made wider at the front than at the back, so that when the rod is inserted with its thinner portion towards the front, its projection from the clamp is greatest at the back. A relatively larger current is thus conducted to the thinner portion to compensate for its more rapid cooling.

R. J. W.-J.

887. *Siemens-Schuckert Three-phase Induction Supply Meter.* (Elektrotechn. Zeitschr. 28. pp. 716–718, July 18, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—The meter described consists essentially of two coupled induction motors, the rotor of each of which consists as usual of an aluminium disc. The retarding torque is provided by the usual permanent magnet which acts on the disc. The stationary part of each motor consists of a shunt electromagnet and two series coils without any cores, there being one coil on each side of the shunt magnet. The core of this magnet consists of a nearly closed rectangular frame, with a narrow air-gap to admit the aluminium disc. Of the main coils of the upper motor, one is inserted into line I, the other into line II; both the main coils of the lower motor are in line III, being connected in series with each other. The shunt coil of the upper motor has one end connected to line II, and the shunt coil of the lower motor has one end connected to line III. The remaining ends of the shunt coils are connected to the ends of a non-inductive resistance, an intermediate point of which is connected, through a choking coil, to line I. The theory of this mode of connection is given.

A. H.

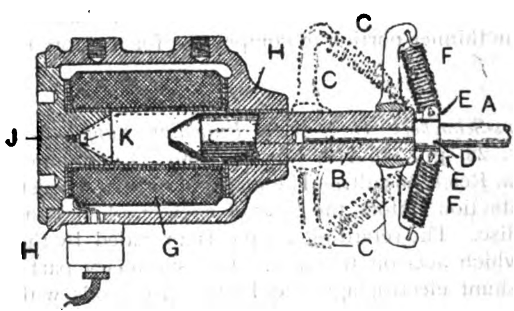
888. *Accuracy of Induction Type Watt-hour Meters.* **H. W. Young.** (Electrical World, 49. pp. 1822–1825, June 29, 1907.)—One great point is accuracy at the lower end of the scale, because for the larger part of time the actual load is but a small percentage of the meter capacity, and meters have a habit of reading slightly low, in favour of consumer. The amount of friction is most important. The "Improved Bearing" is recommended. This consists of a highly polished and hardened steel ball resting between two cupped sapphire jewels, one of which is mounted on a removable jewel screw and the other in a removable sleeve attached to the end of the disc

shaft. The weight of the moving element is also an important factor owing to its evil effect on jewel wear. Another source of inaccuracy is the gradual corrosion of the brass plates and shafts of the registering mechanism.

W. J. C.

889. *Live Wire Indicator.* (Schweiz. Elektrot. Zeit. 4. p. 323, July 6, 1907.) The Oerlikon Co. has patented the following arrangement for ascertaining whether an overhead wire is live. A horizontal metal plate is supported at a convenient distance below the wire, and between the plate and earth is introduced a telephone receiver. In the case of high-voltage conductors (over 20,000 volts), it is not even necessary to use any plate, a simple wire held towards the conductor on one side of the telephone receiver, and a wire hanging down on the other side, being quite sufficient for the purposes of the test. In connection with the latter arrangement, it is not even necessary that the wire hanging from the receiver should be in actual contact with the earth. [Swiss Pat. 37,167.] A. H.

890. *New Design for Electromagnet.* (Mech. Eng. 19. p. 637, May 4, 1907.) —In many instances where electromagnetic devices are employed for actuating mechanisms the pull exerted by the magnet or solenoid is weakest at the start,



when the resistance to the motion is generally greatest. Belliss and Morcom, Ltd., and R. Macgregor have recently patented a method of elastically attaching the movable core or plunger to the rod to be moved, by using a spring of special design which is gradually extended, and whose pull rapidly increases, as the plunger is sucked in by the solenoid. The action will be understood from the Fig. A. H.

891. *Long-stroke Electromagnets.* **Bouchet.** (Soc. Int. Élect., Bull. 7. pp. 327–332, June, 1907.)—In connection with Picou's paper [see Abstract No. 654 (1907)] the author discusses the design of electromagnets the armatures of which have to move through long distances—in some cases more than three times the length of the exciting coil. In designing these electromagnets we have to remember that the law of the variation of the pull depends on the purpose for which the electromagnet is to be used, and with this limitation the weight efficiency T/P, where T is the work done in the stroke and P the weight of the electromagnet has to be made as high as possible. The expenditure of electric energy is generally a secondary consideration in small magnets used only intermittently. But when the weight of the magnet has to be a minimum a high efficiency is essential. Electro-

magnets designed by Guénée are described, in which the desired law of variation of pull is obtained by making the section of the armature variable. An interesting oscillogram is shown of the rise of the current in one of these magnets. Until the armature begins to move the curve is similar to the ordinary exponential curve of the rise of current in an inductive circuit. A momentary drop in the value of the current indicates that the armature has begun to move, and a well-defined cusp gives the point when the armature has completed its stroke. The last part of the curve is the ordinary exponential curve, but owing to the greater value of the inductance it is much less steep than the first part. Long-stroke electromagnets are made of all sizes with pulls varying from a few gm. up to half a ton or more. All the apparatus at the Invalides railway station is worked by electromagnets: signals, points, &c. Many hundreds of tramway cars have their brakes applied by electromagnets. The length of the stroke is 25 cm., and the pull varies from 250 to 500 kg. for carriages weighing from 8 to 18 tons. There are many other applications, starting motors at a distance, opening valves, &c. Drills of the percussion type contain a spring which is compressed by the armature and on its release actuates the drill, giving to it a slight rotary motion. The average force of compression is 180 kg. and the length of the stroke 15 cm. The number of blows in a minute often exceeds 400. The current taken is 16 amps. at 220 volts. All the iron used in the electromagnet has to be very carefully laminated. The drill advances 10 cm. per min. into granite. The efficiency is about 50 per cent., which compares very favourably with drills actuated by any other motive power. The electromagnets used for pile-driving are much larger, the hammer weighing 550 kg.

A. R.

892. *Lightning Arresters.* **E. E. F. Creighton.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 383–408, April, 1907. Elect. Rev., N.Y. 50. pp. 762–764, May 11, 1907.)—The author puts forward as the novel features of a new multi-gap arrester the discovery of a true non-arcing condition of shunted gaps, the combination in a cumulative manner of several shunt resistances, and the design of ohmic resistance by the volume method rather than by the radiating surface. Curves and oscillograms are given to illustrate the phenomena discussed. A new form of arrester of the electrolytic type is described, for which it is claimed that the discharge of electricity at normal pressures is obstructed, while at abnormal pressures discharge takes place freely. Experiments have been made with this type on actual circuits up to 33,000 volts with successful results. The arrangement of the apparatus for making the oscillographic tests is explained.

A. H. A.

893. *Kallmann's Spark-reducing Switches.* (Brit. Pat. 14,058 of 1906. Elect. Engineering, 2. pp. 71–72, July 11, 1907.)—In these switches an iron wire is switched into circuit before the circuit is broken. This iron wire heats and increases in resistance so as to cut down the current sufficiently to enable the circuit to be broken without excessive sparking. A simple circuit-breaker and a cell-switch for accumulator batteries are illustrated. In the accumulator-switch the resistance between the parts of the divided contact-arm consists of iron wire enclosed in a glass reservoir filled with hydrogen. The inventor has used similar resistances in motor starters and for other purposes [see Abstracts Nos. 298, 572 (1906), and 645 (1907)].

C. K. F.

894. *Fireproof Cables.* (Engineering, 83. p. 752, June 7, 1907.)—This article describes a so-called fireproof cable, manufactured by Johnson and Phillips. The core is insulated with rubber, and this is surrounded by several layers of manilla paper, impregnated with a solution which renders it non-inflammable. Over this is a strong woven braiding of steel wires, covered with manilla paper and a braiding of jute, which is also suitably impregnated. An account is given of several tests, which were carried out under very severe conditions, and these tend to show that the cable possesses such properties that it may fairly be described as fireproof. W. H. S.

895. *Electrolysis of Lead-covered Cables.* **F. Fernie.** (Elect. Engineering, 1. pp. 1037–1039, June 20, 1907.)—Some notes on the subject of lead corrosion are here given. Lead is sometimes corroded by chemical corrosion, and the author suggests that the decomposition of wood or other forms of cellulose may generate acetic acid, which might continuously corrode the lead in a manner similar to that by which white lead is made on the Dutch process. Various cases of electrolytic corrosion are also considered, and attention is called to the dangers which may arise in the case of cables which are liable to be flooded from time to time. W. H. S.

REFERENCES.

896. *Calculation of Size of Battery required for a given Output.* **W. Peukert.** (Elektrotechn. Zeitschr. 28. pp. 705–706, July 18, 1907. Écl. Électr. 52. pp. 241–243, Aug. 17, 1907.)—The author gives further examples of the application of his formula [see Abstract No. 386 (1907)], and shows in addition that it applies also in the case of the alkaline accumulator. L. H. W.

897. *Dielectric Losses.* **B. Monasch.** (Electrician, 59. pp. 416–418, June 28; 460–463, July 5; and pp. 504–506, July 12, 1907.)—[See Abstracts Nos. 1084A and 642B (1907).]

898. *Method of Plotting Hysteresis Loop.* **G. Kapp.** (Inst. Elect. Engin., Journ. 39. pp. 225–230, July, 1907. Original Communication. Elect. Engineering, 2. pp. 58–59, July 11, 1907. Electrician, 59. pp. 522–523, July 12, 1907. Écl. Électr. 52. pp. 243–245, Aug. 17, 1907.)—A detailed account of the method briefly described in Abstract No. 287 (1907). A. H.

899. *Measurement of Iron Losses by Three-voltmeter Method.* **H. Zipp.** (Elektrotechnik u. Maschinenbau, 25. pp. 493–494, June 30, 1907.)—The author develops the theory of the three-voltmeter method as applied to the determination of the losses in an iron core surrounded by an exciting coil. The accuracy of the method can be rendered sufficiently high by using the same electrostatic voltmeter for the three readings, and arranging the value of the non-inductive resistance so that these readings do not differ greatly from each other. An advantage which the method possesses over the wattmeter method is the absence of any corrections. A. H.

900. *Theory of Power-factor.* **W. E. Sumpner.** (Elect. Engineering, 1. pp. 752–754, May 2, 1907. Electrical World, 49. pp. 1117–1118, June 1, 1907.)—The advantages of a high power-factor are pointed out, and a very simple proof is given of the fact that in no case can the power-factor exceed unity—no assumption being made regarding the wave-forms. The theory of compensators for raising the power-factor is briefly discussed. A. H.

901. *Cost of Electric Cooking.* C. D. Seaver. (Electrician, 58. pp. 529–530, Jan. 18, 1907. Abstracted from the "Clarkson Bulletin," Oct., 1906.)—The cost of cooking various kinds of foods and the time taken over each operation is set out in tabular form. With electric energy at 2d. per unit the cost is roughly twice that with gas at 4s. per 1,000 cub. ft. L. H. W.

902. *Practical Pyrometry.* R. S. Whipple. (West. Soc. Engin., Journ. 12. pp. 169–199 ; Discussion, pp. 199–202, April, 1907.)

903. *Temperature-coefficient for Copper.* R. T. Glazebrook. (Electrician, 59. p. 65, April 26, 1907.)—In reference to the article by F. B. Crocker [see Abstract No. 882 (1907)], attention is directed to the fact that for most purposes the linear expression is sufficiently accurate, and a table is given of corresponding coefficients determined by various experimenters. [The work of Clark, Forde, and Taylor [Abstract No. 1170 (1899)] is again overlooked. For submarine cable tests, the linear expression is less satisfactory than the table of ratios worked out by Clark, Forde, and Taylor.] R. A.

904. *Wattmeters and Watt-hour Meters.* H. Pécheux. (Écl. Electr. 51. pp. 289–298, June 1, 1907.)—The author first points out the necessity when calibrating a wattmeter of taking into account the watts expended in the ampere and volt coils. In certain cases and at certain loads the errors introduced by these causes compensate one another. Similar remarks apply to watt-hour meters of the rotating type. These meters compare unfavourably with oscillating watt-hour meters which register the energy expended most accurately. A. R.

905. *Effect on the Compass of Electrical Installations on Ships.* C. Garibaldi. (Atti dell' Assoc. Elettr. Ital. 10. pp. 5–15, May–June–July–Aug., 1906.)—An experimental investigation of the effect of the proximity of a dynamo to the compass on the readings of the latter. It is concluded that, with a dynamo of ordinary design, provided its distance from the compass is not less than 30 ft., there is no danger of the compass readings being influenced. L. H. W.

906. *Apparatus for Testing Porcelain Insulators.* W. Weicker. (Elektrotechn. Zeitschr. 28. pp. 283–286, March 28, 1907.)—The author gives a brief illustrated account of the arrangements recently adopted by the Hermsdorf S.-A. porcelain factory for testing high-voltage insulators. The testing transformer has its secondary wound in two sections, which may be connected either in parallel to give a voltage of 100,000, or in series to give 200,000 volts. Special arrangements are provided to study the effects of a driving rain, &c. Besides the purely electrical tests, each insulator is tested for mechanical strength. A. H.

907. *Electric Driving of Spinning Machinery.* K. Schnetzler. (Elektrische Kraftbetr. u. Bahnen, 5. pp. 364–369, July 4, 1907. Paper read before the Elektrotechn. Verein, Dresden, March 21, 1907.)—The author considers the adaptability of the different forms of motor to the driving of cotton-spinning machinery, and describes the special system developed by Brown, Boveri and Co., in which single-phase repulsion motors of the Déri type [Abstract No. 601 (1905)] are used. The required speed-regulation is easily effected by a displacement of the movable brushes. A. H.

908. *Lifting and Transportation Appliances in Steel Mills.* G. Stauber. (Stahl u. Eisen, 27. pp. 965–1051, July 10, 1907. Paper read before the Verein deutsch. Eisenhüttenlente, Düsseldorf, May 12, 1907.)—Of value for reference to the numerous illustrations of electrical apparatus designed to serve special purposes. L. H. W.

GENERATORS, MOTORS, AND TRANSFORMERS.

909. *Magnetic Oscillations in Alternators.* **G. W. Worrall.** (Inst. Elect. Engin., Journ. 39. pp. 206–220; Discussion, pp. 220–224, July, 1907. Paper read before the Manchester Section. Abstracts in Electrician, 58. pp. 727–729, Feb. 22, 1907. Elect. Engineering, 1. pp. 263–266, Feb. 7; Discussion, p. 292, Feb. 14, 1907. Elect. Rev., N.Y. 50. pp. 339–341, March 2, 1907.)—The object of the experiments described by the author was to investigate the flux oscillations occurring in the poles of alternators and in the interpolar space. The method of experimenting was identical with that used in a previous investigation [Abstract No. 1181 (1906)], and consisted in the use of suitably placed search coils connected to an oscillograph. The alternator experimented on was a 4-pole machine with a rotating armature. It was found that oscillations were produced by the armature teeth in the interpolar space. Three classes of oscillations were found to be produced by armature reaction, viz., (1) irregular oscillations, with a period equal to that of a revolution—these appear to be due to some irregularity in construction, or to a local current in the mesh-connected armature; (2) regular, with a frequency triple that of the machine—these only occurred on load; (3) regular, with a frequency double that of the machine—these were found to be produced by unbalanced loads. The author confirmed the fact pointed out by K. Simons [Abstract No. 972 (1906)] that when the number of teeth under cover of the pole-face is greater or less by unity than the number of slots, the ripples introduced into the e.m.f. wave by the teeth exhibit a discontinuity of phase of 180° in the neutral plane.

A. H.

910. *Compounded Commutator Alternators.* **A. Heyland.** (Elektrotechn. Zeitschr. 28. pp. 689–691, July 11, 1907. Electrician, 59. pp. 551–553, July 19, 1907.)—Some notes are given on the running of compounded alternators of the Heyland type [Abstract No. 422 (1905)]. The first machine dealt with is a 450-kw., 88 r.p.m., 25-∿ alternator, which has been in regular operation since the end of 1904 at the works of the Société Métallurgique de Senelle-Maubeuge in Longwy. Three other machines, each of 390 kw. at 375 r.p.m. and 50 ∿, have since the beginning of 1905 been running at Valenciennes, at the works of the Compagnie Générale pour l'Éclairage et le Chauffage par le Gaz. The experience gained with these machines has shown that the commutation difficulty is by no means so serious as has sometimes been represented. Parallel running also presents no difficulty, as has been proved by the machines at Valenciennes. The compounding transformers are in this case connected by equalising bars, so that a common compounding effect is obtained. Experience has shown the desirability of constructing such machines with relatively stiff fields, so as to render them less sensitive to voltage fluctuations arising from changes in speed. The author draws attention to a peculiarity characteristic of alternators of this type: if they are heavily loaded with *leading* currents, they may suddenly lose their field. This effect was originally observed in connection with some small machines used as compensators for supplying the wattless currents to a network. There is, however, but little danger of such an occurrence in the case of large machines.

A. H.

911. *Combined Star and Mesh Windings for Three-phase Machines.* **L. Legros.** (Écl. Électr. 52. pp. 37–41, July 13, 1907.)—It is sometimes useful in practice to be able to vary the terminal potential difference of a three-phase machine by connecting a variable number, $3p$, of the windings in mesh, the remaining $3(P-p)$ windings connecting the angles of the mesh to the machine terminals. It is proved that if V be the p.d. of a machine having a combined star and mesh winding and V_s be the p.d. when p is zero, that is, with a star winding, then we have—

$$V=[(1+x+x^2)/3]^{\frac{1}{2}}V_s, \text{ where } x=(P-p)/P.$$

The resistance between two terminals $=(2/3)Pr(1+2x)$, where r is the resistance of a winding. If the e.m.f. induced in the star portion of the winding lag behind the mesh p.d. at the terminals by an angle a, the current in the star portion of the winding will lag behind it by an angle $30°-a+\phi$, where $\cos\phi$ is the power-factor of the load. The angle of lag in the mesh windings is $\phi-a$, and a can be found by the formula: $\tan a=x\sqrt{3}/(2+x)$. In a star winding, for instance, $x=1$ and therefore $a=30°$. The demagnetising turns due to the armature reaction equal—

$$kA[(P-p)\sin(30°-a+\phi)+(p/\sqrt{3})\sin(\phi-a)],$$

where k is a constant and A the effective value of the line current. This will cause a fluctuation of the magnetic lines in the poles and consequently hysteresis and eddy-current losses. The frequency of these fluctuations is equal to the number of turns of the machine per sec. and is generally very low. For machines with only two or four poles it may be appreciable. Another consequence of the variation in the value of the field flux is an irregularity in the attractive forces. In machines with few poles this irregularity may cause excessive vibrations. The total loss due to the heating of the armature conductors equals $PA^2r(1+2x)$. For the same value of A, therefore, the copper losses diminish as we pass from the star to the mesh connection, but this loss does not compensate for the increased iron losses, and so there is a falling off in the efficiency of the machine the greater the value of p.

A. R.

912. *Properties of Commutator Rotors.* **M. Latour.** (Écl. Électr. 50. pp. 5–12, Jan. 5; 41–46, Jan. 12, and pp. 77–80, Jan. 19, 1907.)—The author discovered experimentally and proved theoretically [see Abstract No. 384 (1902)] that the inductance and commutation of a commutator rotor placed inside an ordinary stator and supplied with polyphase currents depend on the speed of the rotor. About the same time he also discovered that a rotor supplied with single-phase alternating current also exhibited the same phenomena, provided that two extra brushes c and d were placed on the commutator with their axis at right angles to the axis of the brushes a and b connected with the mains and short-circuited. In the theories previously given sine-wave assumptions were made and, in the single-phase case, the resistance of the circuits in which the currents in the short-circuited brushes flow were neglected. The commercial importance of commutator rotors at the present time makes a more complete theory desirable. It is known that the magnetic flux in the air-gap is generally very approximately triangular in shape. It may therefore be written in the form $\Phi_1\sin\theta+\Phi_3\sin 3\theta+\ldots$ where unit current passes through the rotor by the brushes a b. If l be the breadth of the rotor parallel to its axis of rotation, n the number of turns

subtended by a radian, and r the radius of the "magnetic periphery," that is, the radius of the cylindrical surface passing through points giving the mean depth of the windings, we have $L = n r l [\Phi_1 - \Phi_3/3^2 + \ldots]$, where L is the self-inductance of the circuit between c and d. If while unit current is passing through the rotor it be rotated with an angular velocity ω, the e.m.f. developed between c and d will equal $Lk\omega$, where k is the "form characteristic" of the field and in the case considered it equals—

$$(\Phi_1 + \Phi_3/3 + \ldots)/(\Phi_1 - \Phi_3/3^2 + \ldots).$$

Let us now suppose that two-phase currents of frequency $\omega/2\pi$ are introduced into the rotor by the two pairs of brushes. In each circuit two e.m.f.'s are developed in exact opposition of phase—an e.m.f. of self-induction equal to $L\omega A$ and an e.m.f. due to the rotation equal to $Lk\omega_1 A$. The resultant e.m.f. is therefore equal to $L(\omega - k\omega_1)A$. The apparent reactance of each phase is $L(\omega - k\omega_1)$. It vanishes therefore when $\omega_1 = \omega/k$. Hence k has an experimental meaning. It is the ratio of the pulsation (ω) of the alternating current to the angular velocity of the rotor at which the reactance vanishes. When the space distribution of the magnetic flux in the air-gap follows the triangular law, k is very slightly greater than unity, and hence the reactance vanishes at a speed slightly less than synchronous speed. Let us now suppose that the brushes c and d are short-circuited and that a single-phase alternating current is introduced by a and b. The value of the current A′ in the circuit cd will be given by—

$$A' = Lk\omega_1 A/(r^2 + L^2\omega^2)^{\frac{1}{2}},$$

where r denotes the resistance of the rotor. The component of A′ in phase with A equals $A'[L\omega/(r^2 + L^2\omega^2)^{\frac{1}{2}}]$ which also equals

$$k\omega_1 A/[\omega(1 + r^2/L^2\omega^2)].$$

The magnetic flux induced by this component induces in its turn a rotation e.m.f., $Lk\omega_1 . k\omega_1 A/[\omega(1 + r^2/L^2\omega^2)] = Lk^2\omega_1^2 A/[\omega(1 + r^2/L^2\omega^2)]$, between the brushes a and b.

Hence the apparent reactance of the rotor between the brushes a and b will be equal to—

$$L\omega[1 - (k^2\omega_1^2/\omega^2)\{1/(1 + r^2/L^2\omega^2)\}].$$

If k^2 be less than $1 + r^2/L^2\omega^2$, this will vanish at hypersynchronous speed.

Similarly, it may be shown that the apparent resistance between the brushes a and b will be equal to—

$$r[1 + (k^2\omega_1^2/\omega^2)\{1/(1 + r^2/L^2\omega^2)\}].$$

It will be seen, therefore, that the effect of short-circuiting the brushes c and d is to increase the apparent resistance and diminish the apparent inductance between a and b. In a similar way the author discusses mathematically the various methods of compensating commutator motors, and deduces from his equations practical rules for securing large starting torques, &c. A. R.

913. *Large High-voltage Generators.* **B. A. Behrend.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 227–232, Feb., 1907. West. Electn. 40. p. 278; Abstract of Discussion, pp. 278–279, March 30, 1907.)—The author briefly

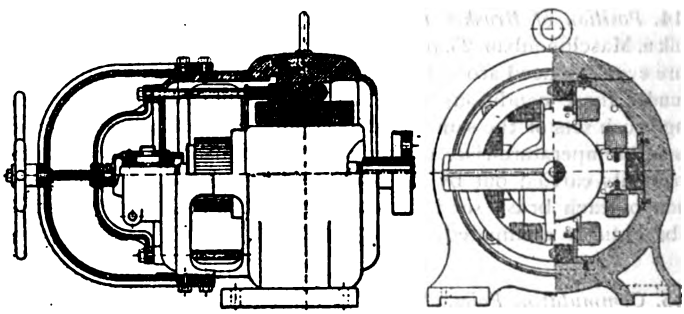
discusses the practicability of winding generators of large output for voltages as high as 20,000, and expresses the opinion that in units of 10,000 kw. and upwards the adoption of this voltage is desirable, and from a constructional point of view quite feasible. The main advantages to be derived from the adoption of so high a voltage consist in the simplification and increased reliability of the plant, and (probably) a slight reduction in first cost. A complete set of spare armature coils should always be provided; the coils would be arranged to be easily replaceable. In order to test the practicability of constructing even small generators for these high voltages, the author has had constructed a 150-kw., 20,000-volt, 600 r.p.m., 60-$\sim$ three-phase alternator. This has been in operation for months, day and night, under full load, and has so far given no trouble. The regulation and other features of this machine are quite satisfactory. A. H.

914. *Position of Brushes in Multipolar Dynamos.* **M. Beck.** (Elektrotechnik u. Maschinenbau, 25. p. 555, July 14, 1907.)—As a general rule, the brush sets are evenly spaced around the commutator. Practical experience shows that under these conditions there are appreciable local currents circulating among brush sets of the same polarity. Such currents increase the armature losses and temperature-rise, and reduce the overload capacity of the machine. Experiments carried out by the author show that by properly adjusting the position of each brush set independently of the others such local currents may be entirely eliminated. A. H.

915. *Commutating Poles.* **W. Wolf.** (Schweiz. Elektrot. Zeit. 4. pp. 313–314, July 6; 325–326, July 13, and pp. 337–340, July 20, 1907.)—The author briefly reviews recent designs of commutating poles. A two-pole commutating magnet has been introduced by the Siemens-Schuckert works. In order to do away with the increase of inductance of the short-circuited coil which is brought about by the commutating pole, the firm just mentioned has adopted the method of skewing the commutating poles. T. Lehmann has designed a form of commutating pole which allows of a variation in the shape of the reversing field curve. The reversing core ends in a narrow blade, to either side of which may be bolted polar expansions, and these expansions may, by means of suitable wedges, be displaced radially, so as either to approach, or to recede from, the armature. Both the central and the side portions of the reversing pole-shoe are skewed. In this way the reversing flux may be adjusted to have the most favourable distribution. Increase of self-inductance in the short-circuited coil may be prevented by slitting the reversing pole radially (several slits of variable width being used in some designs). An over-compounding effect may be obtained by suitably shaping the reversing pole-shoe. In order not to interfere with the ventilation of the machine due to the large spaces between the main poles, several firms use designs in which the reversing pole-shoe alone projects into the interpolar space, the reversing core and its yoke forming an independent structure arranged entirely outside the main field frame. This has the further advantage that the operation of the reversing poles is not interfered with by saturation of the yoke due to the main flux. In cases where both reversing poles and a compensating winding are used it has been customary to connect both windings simply in series with each other. The A.E.-G. prefer to provide the two windings with independent shunts, so that the compensating winding may be adjusted quite independently of the reversing

one. In the case of very large multipolar machines the construction of the reversing-pole winding is greatly facilitated by connecting each reversing-pole coil in the corresponding brush lead, between the brush and the 'bus ring—an arrangement introduced by Messrs. Lahmeyer. A. H.

916. *New Type of Variable-speed Motor or Variable-voltage Generator.* **L. Torda.** (Electrician, 59. pp. 464–467, July 5, 1907.)—The type of machine described by the author, which is being manufactured by the Morris-Hawkins Electrical Co., is one in which the speed or voltage variation is obtained by varying the reluctance of the magnetic circuit. For this purpose, a system of movable iron plates is provided as shown in the Fig. The plates are arranged to slide in openings in the field cores, between the coils and the yoke, and in order to reduce the frictional resistance as much as



possible two of the plates are fitted with rollers. The motion of the plates is effected by means of a screw which passes through a traversing frame. By having the movable plates between the field coils and the yoke it becomes possible to attach them to an *iron* ring (a supporting ring of brass or other non-magnetic material would be required were the plates between the field coils and the armature), and the movable plates, being further removed from the rotating armature, are in a safer position. A small booster set of the above type is fully described; this consists of a motor coupled to two 5-kw. variable-voltage generators, each capable of giving 100 amps., and having a voltage range of from 18 to 52 volts by displacement of the movable plates. Similar machines of larger size are in course of construction. A great advantage of this type of machine is its reliability, due to the absence of a field rheostat. A. H.

917. *Compensated Shunt Motors for Alternating Currents.* **J. Bethenod.** (Écl. Électr. 50. pp. 149–155, Feb. 2; 51. pp. 109–114, April 27; 52. pp. 78–79, July 20, and pp. 145–151, Aug. 3, 1907.)—The introduction of single-phase traction networks serving scattered areas has created a ready market for single-phase motors for industrial purposes. The supply of these motors from the networks is of considerable commercial importance owing to increasing the load factor, and of considerable economic importance, as cheap power would lead to the development of waste land. They are also of importance for the economic transmission of power to considerable distances. For these purposes the Latour single-phase shunt commutator motor is specially adapted. Its speed is constant, it has a good starting torque, the power-factor can be regulated, and it has perfect commutation at all loads. The author has made

a previous theoretical study of this motor [see Abstract No. 906 (1905)]. In order to get a simple working theory he neglected the resistance of the short-circuited brushes. This, however, is not permissible in many practical cases. It is therefore necessary to discuss the problem completely, notwithstanding its great complexity. Let e_1 denote the applied p.d., i_1 the statoric current, i_2 the current flowing in the rotor circuit, and i_3 the current between the short-circuited brushes. Let R_1, R_2, and R_3 denote the corresponding resistances, L_1 the statoric self-inductance, L_2 and L_3 (supposed identical) the inductances of the rotor circuits and $M = [(1 - \sigma)L_1L_2)]^{\frac{1}{2}}$ the mutual inductance between the stator and the rotor. The fundamental equations are—

$$e_1 = R_1i_1 + L_1di_1/dt + Mdi_2/dt,$$

$$e_2 = R_2i_2 + L_2di_2/dt + m\omega i_1 + \mu\omega i_3 ;$$

and—

$$0 = R_3i_3 + L_3di_3/dt + Mdi_1/dt - \mu\omega i_2,$$

where e_2 denotes the p.d. between the main brushes, ω the angular velocity of the rotor, m the coefficient which, when multiplied by the angular velocity, gives the dynamical e.m.f. for unit statoric current, and μ a coefficient analogous to m for the rotor circuits. For a sine-shaped distribution of flux, $m = M$ and $\mu = L_2$. Assuming sine-shaped current and e.m.f. waves, and using the method of the complex variable, the complete solution of the above equations is obtained. The algebraical expressions are naturally very lengthy, but it is easy by their means to see the effect produced by an alteration in the constants. For instance, we can deduce the expression for the speed at which the torque on a single-phase motor vanishes, by putting certain of the constants equal to zero in the expression the author has found for the torque. The condition is also found which determines whether the speed at no load will be hypersynchronous or not. The case when the statoric winding is not uniform is discussed. It is proved that the circle diagram is only an approximation. Finally, the author gives useful graphical methods. A. R.

918. *Iron Losses in Induction Motors.* **T. F. Wall.** (Electrician, 59. pp. 874–877, June 21, 1907.)—In a previous paper [Abstract No. 401 (1907)] the author shows how the iron losses in induction motors with ball-bearings may be separated by the use of retardation curves. When brass bearings are used the method is not satisfactory, as the rotor comes quickly to rest, and its moment of inertia cannot be found by the usual oscillation method. The author has therefore developed another method of separating the losses. The machine is allowed to run on no load with short-circuited rotor, the power supplied to the stator being absorbed in iron, friction, and copper losses. This power is measured for different values of the applied p.d., starting from a pressure above normal and proceeding to the lowest possible value consistent with steady running. A curve is then drawn, having for its ordinates the power supplied to the stator, less the copper losses, and for its abscissæ the applied voltages. Producing this curve to cut the axis of Y, its intercept will give the friction loss. Subtracting this friction loss from the ordinates of the curve, we get the total iron losses. A wattmeter reading is now taken at the stator terminals when the rotor windings are on open circuit, the rotor running at synchronous speed. This gives the power required for the losses in the stator and the hysteresis torque on the rotor. If then we can separate the stator losses and the hysteresis losses, and subtract the former from the

reading with the short-circuited rotor, the total power transferred to the rotor which is required for the friction loss and the loss due to pulsations in the teeth, will remain. The friction loss having been previously found, we at once deduce the losses due to the pulsations in the teeth. The author separates the hysteresis and stator losses as follows. The rotor is driven at different speeds with its windings open, the stator being connected with the supply circuit as usual. For speeds below synchronism the hysteresis produces a driving torque, and for speeds above synchronism it has a retarding effect. The hysteresis torque may be considered to be practically independent of the speed. On passing through synchronism, therefore, the power given to the stator changes instantly by an amount equal to twice the hysteresis torque multiplied by the synchronous speed. By taking a few readings above and below synchronism, and drawing a curve, a break is shown at the synchronous speed, and half this break measures the power due to the hysteresis torque at this speed. All the iron losses are thus found, and the test can be made easily and quickly. The author gives experimental results obtained by his method and by the method of retardation curves. In order to use the latter method it is necessary to know the moment of inertia of the rotor. When the machine has brass bearings the following method of doing this is adopted. The rotor windings being closed through a resistance, the acceleration-curve as the rotor runs up to speed is obtained. The net torque found from this curve would not be the true electrical torque on the conductors as found from the circle diagram, since there is an accelerating moment due to hysteresis and eddy currents, and a retarding moment due to friction and pulsations in the teeth. To find the acceleration which really corresponds to the electrical torque on the rotor conductors acting solely against the inertia of the moving parts, an addition must be made to this acceleration curve. This is obtained by allowing the machine to run down with the rotor-winding open, the flux density being maintained the same. Combining the acceleration and retardation curves, we obtain an acceleration curve corresponding to the turning moment as found from the circle diagram. Since the torque equals the moment of inertia multiplied by the angular acceleration, the moment of inertia can be found. The values of the friction losses found by the two methods in the author's experiments agree to within about 6 per cent. A. R.

919. *Experimental Determination of Losses in Motors.* **C. F. Smith.** (Inst. Elect. Engin., Journ. 39. pp. 437–477; Discussion and Communication, pp. 477–488, Aug., 1907. Paper read before the Manchester Section. Elect. Engineering, 1. pp. 648–650, April 11; 691–693, April 18, and pp. 716–718, April 25, 1907. Elect. Engin. 39. pp. 576–580; Discussion, pp. 580–581, April 26; 620–622, May 3; 650–652, May 10, and pp. 684–687, May 17, 1907.)—In the first part of the paper the author deals with the losses occurring in continuous-current motors. After a detailed review of the various methods which have been suggested at different times for determining and analysing the stray power in continuous-current motors, the results of experiments carried out on a 3-b.h.p. motor are given, the method employed being one involving the use of a separate flywheel which could easily be coupled to, or uncoupled from, the motor. The acceleration and retardation curves, with a constant current maintained through the armature, supply the necessary data for calculating the losses. The author's experiments show a slight increase in the stray-power losses at full load. A detachable flywheel is regarded by the author as furnishing a very convenient method of carrying out the complete test of a motor, and of

analysing the losses; it is suggested that such a flywheel might well form a permanent part of the equipment of a test-room. The second part of the paper deals with polyphase induction motors, and contains a very complete summary of all the more important methods of determining and separating the losses. A. H.

920. *Heating Tests of Stationary Induction Apparatus.* **G. C. Shaad.** (Elect. Journ. 4. pp. 346–351, June, 1907.)—The author discusses the various methods available for the heat tests of transformers, feeder regulators, and induction regulators. Most of the methods described are identical with those mentioned by Gustrin [Abstract No. 787 (1907)]. Induction regulators are easily tested by the "loading-back" method if two of them are available, the primaries being paralleled across the supply mains, and the secondaries Y-connected so as to oppose each other; the full-load currents are easily produced by suitably adjusting the regulators. A. H.

921. *Static Balancers.* **C. C. Garrard.** (Elect. Rev. 60. pp. 985–987, June 14, and pp. 1060–1061, June 28, 1907.)—In order to equalise the voltages in a three-wire direct-current system static balancers are sometimes employed. With rotary converter installations, the middle wire of the direct-current system is frequently attached to the star point of the low-tension side of the transformer supplying the rotary. The author shows that while the balancing results obtained by this method of connection are satisfactory, yet it is an expensive method as the efficiency is low. He considers that in all such systems it would be better to disconnect the middle wire from the star point of the alternating side of the converter and lead back the out-of-balance current into the converter through the slip-rings by means of a static balancer (alternating-current compensator). The calculations show that it is advantageous to lead back the out-of-balance current into the converter by as many points as possible and make the resistance of the balancer windings very small. Experimental data are given of a three-phase balancer designed for dealing with an out-of-balance current of 200 amps. from a 480-volt dynamo, the frequency of the current in the balancer being 25. The results show that it is necessary when considering the design and temperature-rise of such a machine to take into account the increased iron loss due to the out-of-balance current and so design the core that the magnetic flux due to the direct current is a minimum. The author considers that the increased iron loss which always follows when there is a large out-of-balance current in the balancer is mainly due to the losses in the iron tank surrounding it. A diagram illustrating a simple practical method of testing static balancers is given. A. R.

922. *Relative Advantages of Balancers and Three-wire Dynamos.* **B. Frankenfield.** (Elect. Rev., N.Y. 51. pp. 55–59, July 13, 1907. Paper read before the National Electric Light Assoc., June 6, 1907.)—A historical *résumé* is given of the development of the various types of the three-wire dynamo. A description is also given both of the two-wire balancer and of the theory of its operation. The main conclusions may be summarised as follows. (1) Unlike the balancer, the three-wire dynamo cannot be regulated so as to obtain equal voltages. (2) The regulation of a three-wire dynamo on a neutral overload is very poor, but that of the balancer is good. (3) The two-wire plant with balancer consists of standard apparatus

throughout; quick delivery, therefore, can be guaranteed. (4) Faults on a three-wire dynamo are difficult to locate; it also requires expensive switchboard connections. (5) In bringing three-wire dynamos up to speed and connecting in parallel there is a real risk of a violent short-circuit; it also requires *two* double-pole circuit-breakers. (6) The three-wire dynamo plant requires two equalisers, but the two-wire balancer plant requires only one. When compound balancers are operated in parallel the equaliser outlay is insignificant. (7) The balancer can be located at a distance from the station and is not limited to isolated plant service. It will be seen that the author is strongly in favour of the two-wire balancer as used in ordinary Continental practice. He thinks that the present vogue in three-wire dynamos in America will not continue, and states that the two-wire balancer is already in extensive use. A. R.

923. *Protection of Transformer Insulation.* **W. S. Moody.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 689–694, May, 1907. West. Electn. 41. p. 5, July 6, 1907.)—The author considers the best arrangement to be that in which the end turns are more heavily insulated than the middle portion of the winding, and in which, as an additional safeguard, a small reactance coil is inserted between the line and the transformer. Since in almost every case the transformer is required to be capable of operating at several voltages, taps have to be provided for this purpose, and in the ordinary type these taps would be arranged near one end of the winding. This, however, would introduce serious difficulties in the case of a transformer with reinforced end-insulation, as the number of end turns requiring extra heavy insulation would be greatly increased by the presence of the taps. In the type of transformer considered by the author this difficulty is overcome by dividing the winding at its middle point, and arranging taps by means of which the desired number of turns may be left out at the *middle* of the winding. A large number of transformers, varying in output from 800 to 7,500 kw., and in voltage from 5,000 to 80,000, have been built on this plan. Some of these have been provided with a small protective reactance, others not; and during the three years that they have been in operation there has not been a single case of failure of insulation. A. H.

924. *Transformers for supplying Rotary Converters.* (Canad. Elect. News, 17. p. 176, June, 1907.)—In the transformers used in connection with the rotary converters of the Manchester and Nashua Street Railway, New Hampshire, each transformer is provided with a double secondary; the alternating-current sides of the rotaries are thereby kept apart, each rotary having its own secondary. The secondaries are further provided with suitable taps, so that the rotaries may be operated at three different voltages —viz., 396, 376, and 360 volts. A. H.

925. *Behaviour of Transformers of Abnormal Construction.* **H. Zipp.** (Elektrische Kraftbetr. u. Bahnen, 5. pp. 383–389, July 18, 1907.)—The author studies the behaviour of a transformer which is either of abnormal construction or which is working under abnormal conditions. In a transformer whose primary copper loss is high, the primary current first decreases and then increases with gradual increase of load from zero value. An induction coil is a transformer to which the ordinary transformer diagram does not apply, as the conditions more nearly resemble those of a short-circuited transformer of ordinary construction. A. H.

REFERENCES.

926. *Armature Laminations for Dynamos.* **H. M. Hobart.** (Mech. Eng. 19. pp. 5–9, Jan. 5; 42–46, Jan. 12, and pp. 76–79, Jan. 19, 1907.)—Describes the preparation and testing of the sheet-iron employed, and gives illustrations of the instruments and tools used for this purpose. The magnetic testing is very fully dealt with. In connection with hysteresis-testers it is stated that "though it is said that the results as given by the Blondel-Carpentier instrument are somewhat higher than with the Ewing instrument [as would be expected since the magnetising cycles are completely different], there should be no difference." L. H. W.

927. *Graphical Methods of dealing with Commutation Problem.* **H. Linsenmann.** (Elektrotechn. Zeitschr. 28. pp. 506–509, May 16, 1907. Écl. Électr. 51. pp. 379–382, June 15, and pp. 417–420, June 22, 1907.)—The author shows how the differential equation of commutation established by Arnold and Mie [Abstract No. 1084 (1899)] may be solved by graphical methods. Two such methods are described. The first is generally applicable to differential equations; the second is particularly useful in connection with the commutation problem, and is much more rapid than the analytical method. A. H.

928. *Continuous-current Armature Windings.* **H. M. Hobart.** (Elect. Rev., N.Y. 50. pp. 519–522, March 30; 554–556, April 6, and pp. 590–592, April 13, 1907.)—A very simple account of the more important types of armature windings for continuous-current machines. A. H.

929. *Calculation of Magnetising Current of Polyphase and Single-phase Windings.* **W. Kummer.** (Elektrotechn. Zeitschr. 28. pp. 645–646, June 27, 1907. Rev. Électrique, 8. pp. 33–34, July 30, 1907.)—The author applies the field vector diagram established by Görges [Abstract No. 48 (1907)] to the calculation of the magnetising current, and compares the results with those obtained by the method of analysing the magnetic flux wave into its simple harmonic components. The method of Görges is further extended to various single-phase windings not treated by him, and the results are compared with those of the harmonic analysis method. Perfect agreement is in all cases obtained between the results of the two methods. A. H.

930. *Eddy-current Losses in Alternating-current Machines with Elliptic Rotating Field.* **R. Rüdenberg.** (Elektrotechnik u. Maschinenbau, 25. pp. 533–536, July 7, 1907. Écl. Électr. 52, pp. 201–205, Aug. 10, 1907.)—This is a mathematical investigation of the eddy-current losses occurring in single-phase commutator motors, the method employed being similar to that used by the author in a previous investigation [Abstract No. 323 (1906)]. A. H.

931. *Vector Diagram of Compensated Single-phase Series Motor.* **W. I. Slichter.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 759–764, May, 1907.)—The author constructs a vector diagram of the compensated series motor, taking into account the effect of the short-circuit currents in the coils undergoing commutation. A. H.

932. *"General Electric" Commutating Pole Railway Motors.* (Street Rly. Journ. 29. p. 1112, June 22, 1907.)—The General Electric Co. has recently developed a line of railway motors fitted with commutating poles, ranging in output from 50 to 200 h.p. The advantages claimed are sparkless running, reduced wear of commutator and brushes, increased efficiency, and greater reliability. The motors are at present constructed for voltages not exceeding 600. A. H.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

933. *Hydro-electric Plant.* **F. Osgood.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 441–461, April, 1907.)—The author describes the preliminary investigation of a water-power development, with practical notes on the features to be considered, and the precautions to be taken in laying out the dam and canal. The next step is to ascertain the probable nature of the load, and to adopt a suitable voltage, which must be considered in connection with the speed of the turbines determined by the available head. The type of wheel and housing depends upon the head, and the size of the smallest unit should correspond with the minimum flow if the supply of water varies greatly; but it is preferable to have all the machines of the same size. Electrically-driven exciters are best, but there must be one water-driven, with a spare. Water-wheel governors should be electrically controlled from the switchboard. Oil switches should be used, in separate chambers with glazed fronts. Oil-filled water-cooled step-up transformers are preferable to the air-blast type, one to each phase, in duplicate if possible. Abundant space in the high-pressure room is essential. Steel poles are best for the line, and where the lines are in duplicate the nearest wires of the two sets should be 25 ft. apart. Porcelain insulators are recommended, and a separate telephone line is a necessity. A small staff can work the station, but the operators should be highly skilled, and separate staffs should be provided for the hydraulic plant and the line. The importance of good organisation and harmonious working is emphasised, and the paper concludes with a number of practical notes.

A. H. A.

934. *Electricity Supply to Outlying Districts.* **R. L. Acland.** (Electrician, 59. pp. 486–488; Discussion, p. 488, June 28, 1907. Elect. Engin. 39. pp. 897–899; Discussion, p. 899, June 28, 1907. Abstract of paper read before the Municipal Elect. Assoc., June 25, 1907.)—In order to supply a small area 1¼ miles beyond the edge of the existing network, a 50-kw. direct-current motor-generator was put down in a substation and supplied from the trolley-wire feeder of the tramways, which ran out to the district in question. To overcome the wide variations of voltage on the feeder, a Tirrill voltage regulator was connected to the generator field, giving a satisfactorily uniform voltage on the distributing mains. The total cost was £600, about one-third of that necessary to supply direct from the generating station at high pressure. The machine ran all day without attention, from 6 a.m. to midnight. In the *discussion*, **G. Wilkinson** said he had used the Tirrill regulator with satisfactory results to control an alternator. **S. L. Pearce** thought that interruptions would occur through short-circuits on the tramways opening the circuit-breakers. **H. Richardson** preferred high-pressure supply. **A. C. Cramb** had found the Tirrill regulator more effective with alternators than with direct-current generators. **C. Turnbull** suggested separate excitation of the fields to reduce the currents dealt with by the relay. **V. A. H. McCowen** said that at Salford several 800-kw. machines were controlled by a Tirrill regulator. **E. Garton** said that on the Liverpool and

Southport Railway, with a variation from 420 to 680 volts, the regulator kept the voltage constant within 1¾ per cent. In reply, the **Author** said the feeder pressure varied between 460 and 540 volts; the flywheel effect of the armatures of the motor-generator helped to smooth out the irregularities. The generator circuit-breakers were provided with time-limit relays, and those in the feeder pillar were replaced by the tramway officials. **S. E. Fedden** stated that he had used the Tirrill regulators for three years at Sheffield, and could not keep the pressure steady without them, but they required attention. Several of the speakers discussed the use of platinum and silver for the relay contacts, generally in favour of silver. A. H. A.

935. *One-phase High-tension Power Transmission.* **E. J. Young.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 735–741, May, 1907.)—The writer suggests that for long-distance power transmission a single-phase line would have several advantages. Although the present three-phase system is more flexible than the direct-current, it is more complicated and the transmission material required is more expensive. The ordinary one-phase system is simpler than either, but it requires a greater expenditure in copper for the transmission lines. The author would earth the middle point of the winding of the step-up transformer. At the distributing station a motor-generator set consisting of a one-phase synchronous motor and a three-phase power and lighting generator would be used. The design of the line is worked out when 15,000 kw. has to be transmitted 100 miles with a 10 per cent. loss in the mains. The pressure between the mains is 100 kilovolts, but between either and earth 50 kilovolts. It is found that, so far as transmission material is concerned, the direct-current system is far more economical than either the three- or one-phase system. The advantage of the alternating-current system lies in the power-house and the distributing station. Alternating-current generators are cheaper than direct-current machines of equal power, and the author shows how the alternating-current apparatus may be economically placed. On comparatively short transmission lines the disadvantages of one-phase operation would probably outweigh the advantages, but on very long transmission lines or for electrifying railway lines single-phase is the simplest and the most trustworthy in operation. A. R.

936. *Some New Flywheel Storage Systems.* **A. P. Wood.** (Inst. Elect. Engin., Journ. 39. pp. 414–428; Discussion and Communication, pp. 428–436, Aug., 1907. Paper read before the Manchester Section. Electrician, 58. pp. 770–771; Discussion, pp. 771–772, March 1, 1907. Abstract.)—After briefly dealing with the better-known systems the author describes more fully a new method, having a 3-phase flywheel storage set which consists of a synchronous motor whose stator is capable of being rotated in either direction by means of a small auxiliary motor. For the exact details of the arrangement the original paper should be referred to, also for the consideration of the theory and operation of the arrangement, which are dealt with in the discussion.

L. H. W.

937. *Depreciation.* **R. Hammond.** (Inst. Elect. Engin., Journ. 39. pp. 270–280; Discussion and Communications, pp. 280–301, Aug., 1907. Electrician, 59. pp. 51–53, April 26; Discussion and Communications, pp. 103–105, May 3, 1907. Abstract.)—The paper is unsuited for a brief abstract, but the author's table, giving what he considers is a fair approximation of the life of the

various classes of machinery and apparatus, is here reproduced together with a table showing the life and residual value at end of life, according to W. Preece, in percentage of original cost, quoted by **W. R. Cooper,** and one by **T. C. Parsons,** given in the discussion and communications respectively :—

HAMMOND.

Estimated Years of Life.

	Years.
Land and Buildings	60
Machinery and Plant—	
Boilers	20
Pumps and Pipework	25
Conveyors	10
Engines	25
Turbines	20
Dynamos and Alternators	25
Motors	20
Tools and Sundries	10
Accumulators	15
Transformers, Static	25
Converters, Rotary	20
Switching Apparatus and Instruments	20
Meters	10
Mains—	
Armoured	25
"Solid" System	30
"Ducts" System	80

PREECE.

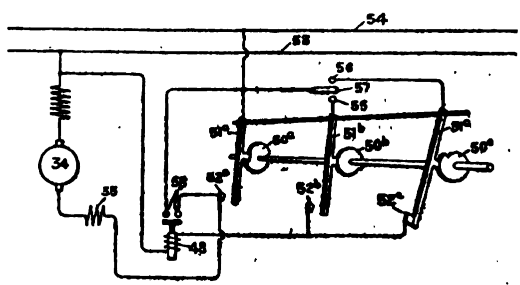
	Life in Years if Properly Maintained.	Residual Value at End of Life. Per Cent. of Original Cost.
Land	—	—
Foundations	100	nil.
Buildings	80	nil.
Boilers (water tube)	25	5
Lancashire Boilers	22	3
Dynamos and Alternators	30	8
Engines and other Machinery	25	6
Cables (armoured)	35	15
Cables (solid in wood trough)	40	12
Buildings (substation)	50	nil.
Substation Equipment	25	12
Accumulators	15	10
Arc Lamp-posts	40	5
Arc Lamps	12	5
Motors	25	9
Meters	12	2
Accessories and Instruments	12	2
Tools and Sundries	10	5

PARSONS,

	Life.	Residual Value. Per Cent.
Machinery	27	6
Accumulators	15	10
Mains	30	15
Motors	25	9
Meters	12	5
Instruments	12	5

L. H. W.

938. *Switch-operating Mechanism for High-potential Circuits.* (U.S. Pat. 848,070. West. Electn. 40. pp. 406–407, May 11, 1907. Abstract.)—The invention of T. E. Button is stated to provide a lighter form of operating mechanism for a number of contacts than is usually met with in heavy switch



design and construction. A motor is used to actuate the switching motion, and the type of switch described is a triple-pole oil break with a separate oil tank, in a brick compartment for each pole. The mechanism is mounted on a cast-iron base-plate resting on the tops of the brick cells. The motor is used to wind up powerful springs which throw the switch in or out as required. A magnetic clutch and free wheel form part of the mechanism. In addition to winding the springs the motor sets a toggle motion on a dead centre,

leaving this in the operating position. The knuckle of the toggle is broken by a blow from a powerful tripping coil which can be energised either from a push button or relay. The connections of the motor circuit are varied by small switches actuated by cams on one of the lay shafts driven by the motor. A diagram showing the chief connections is given in the Fig. The cams are shown at *50a*, *50b*, *50c*, and they lift contact fingers *51a*, *51b*, *51c*, moving them in and out of engagement with contacts *52a*, *52b*, *52c*. Contacts 55, 56, 57, are on the control board, and they serve to close the trip coil (48) circuit either through the contact *52c* or *52b* according to the position of the switch. The circuit across contacts 58 is also closed, and the motor 84 starts and the magnetic clutch 85 is energised. Rotation of the cam-shaft raises contact arm 51*a* to contact 52*a*, at the same time 52*c* is opened and the trip coil is de-energised to allow the toggle to reach its central position. The motor meantime keeps running through contact 52*a*. This circuit is then broken, but not before that at 52*b* is made in readiness for the movement of switch 57 to make the circuit through the trip coil 48 for closing the main switch. This cycle is repeated for each opening and closing of the switch. W. E. W.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

939. *Electrical Exhibits at the Nuremberg Exhibition*, 1906. **K. Meyer.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 862–868, June 1, 1907.)—The machines and apparatus described were exhibited by the Siemens-Schuckert works. The turbo-generators consisted of (1) a 655-kw., 3,000-volt, 1,500 r.p.m. 3-phase alternator, having a cylindrical 4-pole rotating field magnet without any polar projections; the field winding is embedded in slots and held in position by means of wedges, and the projecting end portions are secured by means of steel rings; the peripheral speed is 65 m./sec.; and (2) a 450-kw., 220–250 volt, 2,500 r.p.m. continuous-current generator, having a toothed-core armature and a bar winding secured in the slots by means of wedges of vulcanised fibre; the end portions of the winding are held in place by bronze caps. The peripheral speed is 86 m./sec., that of the commutator being 47 m./sec. The other exhibits described comprise a constant-current transformer with movable secondary, and various types of switchgear. A. H.

940. *Brembana Valley Single-phase Railway*. **A. Soulier.** (Ind. Élect. 16. pp. 275–279, June 25, 1907. Elect. Engin. 39. pp. 891–892, June 28, 1907. From L'Elettricista, Rome. Elect. Rev., N.Y. 50. pp. 1012–1015, June 22, 1907.)—This Italian railway, which has a total length of 30 km., connects Bergamo (altitude 247 m.) and San Giovanni Bianco (altitude 400 m.). It is a single-track line, having a gauge of 1·44 m., with maximum gradients of 2·4 per cent., and curves of a minimum radius of 150 m. Power is generated in the form of single-phase current at 6,000 volts and a frequency of 25 in a hydro-electric generating station, and is supplied direct to the 6,000-volt trolley line. The generating plant comprises three 500-kv.a. units for supplying current to the railway motors, and a 50-kw. alternator for lighting the stations. The alternators are 6-pole Westinghouse machines. The trolley wire is 8-shaped in cross-section, and is supported at 6 m. above the rail level by hangers attached to a messenger catenary cable consisting of 7 strands of steel wire, each 2 mm. in diam. The normal length of span is

85 m., and the sag of the messenger cable is 80 cm.; there are 14 hangers per span. Connected in parallel with the trolley wire is a feeder of the same size, 50 sq. mm. in cross-section. This is intended to allow of any section of the trolley line being disconnected without causing a break in the circuit. In addition to the trolley wire and feeder, there are two 4 mm. overhead copper wires forming the station lighting circuit. At the generating station a Tirrill voltage regulator is provided. There are 5 locomotives, each capable of hauling a 90-ton train at a maximum speed of 60 km. per hour. A pantagraph bow trolley is used for collecting the current. Each locomotive is equipped with four 50-kw. single-phase compensated series Westinghouse motors, which receive current at 250 volts from an artificially cooled auto-transformer provided with the usual taps for gradually raising the voltage at starting. The armature is provided with high-resistance German silver connectors arranged at the bottoms of the slots. A. H.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

941. *Recent Improvements in Railway Motors and Control Systems.* G. H. **Hill, C. Renshaw.** (Street Rly. Journ. 29. pp. 1157–1159, and 1160–1167, June 29, 1907. Papers read before the Street Rly, Assoc. of the State of New York, June 25–26, 1907.)—These two papers contain a general survey of recent advances and improvements in electric railway engineering. G. H. Hill, dealing with recent types of railway motors, considers field-coil insulation, lubrication of bearings, shaft and gear strength, and commutation. The modern field coil is of the "mummy" type, heavily wrapped and not provided with any special supporting bobbin; the vacuum process is used for expelling all moisture and air and thoroughly impregnating the coil with insulating compound. The "mummy" coil is more compact than a spool-wound coil, is less affected by a gradual shrinking of the covering, and can be held more effectively against vibration and chafing. The transition from grease to oil lubrication has proved a great practical advance, has greatly reduced the cost of inspection and maintenance, and has probably doubled the life of the bearings. An oil-lubricated bearing may be relied on to have a life of 50,000 car-miles. One gill of oil for the commutator end bearing and 1·5 gills for the pinion end bearing should be sufficient per 1,000 car-miles. The qualities of the shaft and pinion materials have been greatly improved; shaft material is obtainable having a tensile strength of 70,000–75,000 lbs./sq. in., and pinion material of 85,000 to 100,000 lbs./sq. in. The author does not consider the average quality of carbon brush obtainable in America satisfactory. Commutating-pole motors are referred to in very favourable terms. A considerable number of improvements has been effected in the details of controllers. Among these is the improved construction of the blow-out magnets, a number of separate coils, each placed close to the arc which it controls, being provided instead of the single-coil magnet formerly in use; the field is so arranged as to blow the arc outwards instead of sideways. The controller cylinder is made up of cast segments mounted upon an insulated hexagonal shaft by means of flat keys and set-screws. The connections of the motors have also undergone some changes of importance. In order to prevent the opening of the circuit and the unpleasant jerk when

[1] Non-electrical Automobiles are described in the Section dealing with Steam and Gas Engines.

passing from the series to the parallel connection, the bridge form of transfer is fitted to some controllers, and although this requires extra control fingers and complicates the construction, its adoption is fully justified by the results. Another change is that of reversing the motors by reversing the fields instead of the armatures, the fields being on the earth side ; this has the advantage that the reversing cylinder is not subject to a high voltage, but only to the 20 volts which represent the maximum drop over the field. The trolley wheel used for high speeds is 5¾ in. in diam., and has a bearing 3 in. long with a ½-in. pin. C. Renshaw deals with inter-pole motors, strongly favouring their use, and with the unit-switch system of control, which, though originally designed for multiple-unit train operation, is now being largely used in connection with single cars. In this system the drum of the drum type of controller is replaced by a group of 10 or 12 independent or unit switches, each provided with a strong magnetic blow-out and normally held open by a powerful spring. Each switch is closed when desired by a pneumatic cylinder supplied with compressed air from the brake system. The reverse drum of the usual type of controller is replaced by a "reverser," and the overhead circuit-breaker by a "line switch," both operated pneumatically. The admission of air to the pneumatic cylinders is effected by magnetically controlled valves, current to which is supplied by a 14-volt secondary battery, through a master controller. The two batteries (only one of which is in use at a time) are charged by being connected across a resistance included in the circuit of the pump motor. The master controller has 8 notches for forward running and 8 for reverse. On the first notch resistance is included in the motor circuit; when the handle is moved to the second notch the unit-switches close automatically one after another, at a speed such that the normal current is never exceeded, and the full series connection of the motors is obtained. Moving the handle to the third notch causes additional switches to close which give the full parallel connection. Illustrated details are given of the switch groups and reverser. Single-phase traction is briefly dealt with, and it is stated that during the last 2½ years 15 single-phase railways have been put in operation in the United States. A. H.

942. *Investigations relating to Voltage Drop along Single-phase Railway Lines.* **L. Lichtenstein.** (Elektrotechn. Zeitschr. 28. pp. 620–627, June 20, and pp. 646–651, June 27, 1907. Écl. Électr. 52. pp. 167–170, Aug. 3; 205–210, Aug. 10; 245–249, Aug. 17, and pp. 280–282, Aug. 24, 1907, *et seq.*)—In order to obtain sufficient experimental data for predetermining the voltage drop along a single-phase railway line, the Siemens-Schuckert Works decided to carry out a number of investigations, which were entrusted to the author. The formula given by Maxwell for the self-inductance L per unit length of a loop consisting of two parallel wires, of radii R and r, and placed a distance ρ apart, is—

$$L=\frac{1}{2}\left(\mu_1+\mu_2+4\mu_0\log\frac{(\rho-R)(\rho-r)}{Rr}\right),$$

μ_1, and μ_2 denoting the permeabilities of the wires, and μ_0 that of the medium surrounding them. If the first conductor consists of copper and the second of iron, the formula reduces to $L=\frac{1}{2}\left(1+\mu+4\log\frac{(\rho-R)(\rho-r)}{Rr}\right)$; the permeability μ is here not the ordinary permeability, but corresponds to a value determined by the distribution of the current over the cross-section of the conductor. The author's preliminary experiments, in which a rectangular loop was used, one side of which consisted of steel rods (of radii R equal to

1·5 cm., 2·5 cm., and 3·6 cm. in the various experiments) and the remaining three sides of copper, yielded values of the "equivalent permeability" μ, ranging from 81 to 78; this extremely low value is to be accounted for by the fact that the outer layers were strongly saturated at the currents used (100–500 amps.). Experiments carried out with steel rails yielded still lower values of μ (of the order of 10); these values being calculated by using for R in the above formula the radius of a circular conductor of cross-section equal to that of the rail. A large number of measurements were then made on the Marienfelde-Zossen line; the results are given in tabular form, and show the power-factor, equivalent resistance, and equivalent permeability corresponding to various frequencies and currents. The values of μ range from about 8 to about 20. The ratio of the alternating-current resistance to that with continuous current was found to vary from about 5 at a frequency of 50 to about 2 at a frequency of 25, and to increase with increase of current. Further experiments deal with the measurement of earth currents, the resistance between earth-plates, the potentials of different points of the rails relatively to earth, the disturbance of neighbouring telegraph and telephone lines and various capacity measurements. A. H.

943. *Brennan Mono-Railway.* (Electrician, 59. pp. 172–174, May 17, 1907. Engineer, 103. pp. 480–481, May 10, 1907. Écl. Électr. 51. pp. 352–353, June 8, 1907.)—A short account of the means employed by L. Brennan for balancing a vehicle, which has its centre of gravity above the running wheels, on a single line of rail. The gyroscopic principle is applied, there being two oppositely revolving wheels rotating in a vertical plane. The wheels are supported on trunnions, which permit of their being displaced in azimuth but not in altitude, and the two trunnions are interconnected by some form of toothed sector. The system of the two wheels is mounted on a trunnioned frame which is free to move on a horizontal axis coincident with the centre line of the car. As a result, when the car tends to roll over, the frame remains horizontal, thus altering the relative positions of the frame and the car body. This displacement is caused to act upon the gyroscope in such a way as to tend to accelerate the precession, which results in the centre of gravity being raised, a mechanical pressure being exerted in an upward direction. Although a more detailed description is given in the original, the actual arrangements employed in the model, which was exhibited at the Royal Society's Conversazione, differ from this, and are not disclosed. The model was an electrically-driven car, capable of carrying a man of 10 stone weight. The gyroscope wheels were maintained in a vacuum, and ran at 7,000 r.p.m., being driven by an electric motor. A full-size car is being constructed.

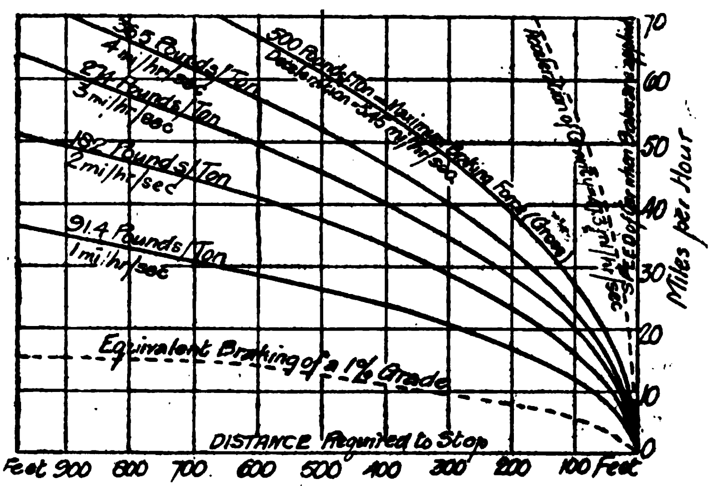
L. H. W.

944. *Electric Braking with Single-phase Commutator Motors.* **W. Kummer.** (Elektrische Kraftbetr. u. Bahnen, 5. pp. 361–364, July 4, 1907. Écl. Électr. 52. pp. 174–176, Aug. 3, 1907.)—The author gives an account of some experiments carried out with single-phase commutator motors used as electric brakes. The motor was supplied with current from the secondary of a transformer, and a variable resistance was included in the circuit. A continuous-current dynamo was coupled to the motor, and could be used either as a load for the motor, or for driving the motor in the reverse direction, causing it to act as a generator, and thereby exert a braking effect. The mode of action of the motor when driven as a generator was found to depend on the resistance included in its circuit.

When the resistance was entirely short-circuited, the motor ran as a continuous-current generator. On introducing a small amount of resistance, the current was found to consist of a continuous current, having an alternating component superposed on it; and on still further increasing the resistance, the current became a pure alternating one. In no case was it found possible to cause power to be returned to the primary of the transformer. This winding under all conditions absorbed power from the mains, and the minimum amount of this power seemed to correspond to the iron losses of the transformer. If the transformer is provided with arrangements for varying the secondary voltage—which is invariably the case in connection with railways—then by suitably varying this voltage the braking current in the motor circuit may be maintained steadily at its normal value, while at the same time the current in the primary may be below its normal value.

A. H.

945. *Electric Car Braking.* **H. T. Plumb.** (Street Rly. Journ. 29. pp. 961–968, June 1, 1907. Abstract of paper read before the Indiana Engin. Soc.)—The writer describes the phenomena of electric car braking in a very clear and interesting manner. The only strictly novel contribution, however, is the set of curves reproduced in the accompanying Fig. These are useful



Speed-distance Curves Corresponding to several Rates of Deceleration.

in showing the distance covered by a car after the application of the brakes for various rates of braking, expressed in brake pressures or decelerating rates. The curve marked "maximum braking force" is allocated on the assumption that the maximum coefficient of friction between a rolling wheel and the rail is 25 per cent. This corresponds to a gross braking force of 500 lbs. per ton weight of the car. As a matter of safety, the retardation must never reach this limit, for if the wheels slip they will lose their advantage, because the coefficient of friction of a sliding wheel is only about half that of a rolling wheel. The writer points out that there are other reasons why the braking force must never reach the theoretical limit—the coefficient

may be reduced because of a slippery rail due to mud, wet leaves, &c. The effective weight on each wheel is changed at the time of braking because the car pitches forward on to the front axles. Thus the rear wheels may skid, although the average braking force may have been safely proportioned to the total weight of the car. The last objection may be partly overcome by a proper proportioning of brake levers. H. M. H.

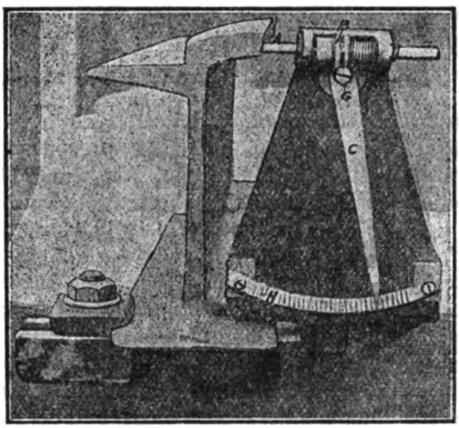
946. *Electric Working on the Mersey Railway.* (Elect. Engineering, 1. p. 879, May 23, 1907. From the "Railway Gazette.")—The following figures give the relative cost of steam and electric working on the Mersey Railway:—

	Steam.		Electric.	
	Total.	Per train-mile.	Total.	Per train-mile.
	£	d.	£	d.
Locomotive	17,660	13·65	20,459	5·95
Maintenance of permanent way ...	6,055	4·7	2,970	0·86
Repairs of rolling stock	2,160	1·66	4,748	1·37
Traffic..	17,611	13·50	21,864	6·35
Total	43,486	33·51	49,636	14·53
Train-miles	311,360		829,188	

These figures show clearly that the chief advantage of electrification is the ability to increase the train-mileage without a corresponding increase of expenditure, rather than a reduction of expenditure with existing train-mileage. L. H. W.

947. *Causes of Rail Corrugation.* **H. B. Nichols.** (Tram. Rly. World, 21. pp. 394–395, May 2, 1907. From "Official Circular" of the Tramways and Light Railways Assoc., April, 1907. Abstracts in Elect. Engineering, 1. p. 742, May 2, 1907. Eng. Rev. 16. pp. 423–425, June, 1907.)—Numerous theories have been advanced as to the cause of rail corrugation, but according to the author, who is the engineer of way of the Philadelphia Rapid Transit Co., vibration is responsible. Vibration either in the rails or in the entire track structure; that is, the wheels of motor or other power-driven cars have a tendency to skid or slip because of the rapid vibration of the rails, which, by reason of the inertia of the car, the wheels are unable to follow instantaneously, thereby causing friction between the wheels and rail to vary in accordance with the wave-length of the vibration. The corrugations may arise from any one of four different causes, viz., the vibration or lateral bending of the web of the rail itself; the rails being loose on their supports; the ties being loose on their foundations; the vibration or movement of the foundation immediately under the track structure. Each condition produces corrugations of a different character, which can be ascertained by examining the head of the rail. The author is certain that in most cases a careful inspection would show that there is a slight movement between the

rail and its supports, and he has made a number of experiments and trials to verify his theory, and one case in point is given. About five years ago it was proposed to reconstruct a section of double track about 2,000 ft. in length, using a 90-lb. 9-in. girder rail laid on ties on a gravel base. When the excavation was made, however, the earth was found to be very spongy, consisting of clay and water-bearing gravel. For this reason the excavation was carried about 7 in. below the ties, and the space filled with concrete to a point 1 in. below the grade of the bottom of the ties. The ties were then carefully tamped with a mixture of fine concrete, and the space between them filled to the base of the rail, which was also tamped. An additional 2 in. of concrete were then placed as a foundation for the paving. After a year's service the rails of both tracks were found to be badly corrugated over practically their entire length. A careful examination was made in order to ascertain the cause of this trouble, the paving and the concrete



above the ties being removed and measurements taken to see if there were any vertical movement in the road-beds or rails, but none could be detected. It was thus evident that if the writer's theory was correct, there must be a lateral bending or vibration of the rail itself, and an instrument was constructed, as shown in the accompanying illustration, in order to find out if this were a fact. It will be noted that the frame may be rigidly clamped to the base of the rail, and that the vertical arm is provided with a piston A carrying a nut B, the piston being forced against the head of the rail by a spring behind the nut. A hand or pointer C is pivoted at G, the upper end of this hand engaging the nut, the other end resting on a graduated arc. The lengths of the upper and lower arms of the pointer are in the ratio of 10 to 1, each graduation representing $\frac{1}{64}$ in. To use this machine it is only necessary to clamp to the base of the rail and set the lower end of the hand at zero, which can be done by turning the piston in the nut. The amount of lateral motion in the head of the rail, due to bending or buckling of the web, will then be indicated by the marker H, which is placed against the hand before a car is allowed to run over the rail. In many cases a movement of $\frac{3}{32}$ in. was noted. In order further to verify the results of this experiment, fish-plates, 80 ft. in length, were secured and bolted to the outside of the rail, thus giving a support to the head and greatly stiffening the entire rail. After a few months it was found that rails thus equipped were

rapidly losing their corrugations. This manner of strengthening the rail is too expensive to be practical, and a special brace is now used on each alternate tie along the outside of the rails. All of the corrugations have practically disappeared. C. E. A.

948. *Retardation of Trains by Side-wind.* **W. E. Wilson.** (Engineering, 83. pp. 457–458, April 5, 1907.)—To keep speed constant when there is a strong side-wind, express trains have to burn more coal than normally. This is usually attributed to increased flange friction, but the author shows that considerable retardation must result from energy expended in accelerating the air which traverses the spaces between consecutive coaches. In a particular case, which is fairly representative, it is calculated that for each such space the engine would require to develop about 57 h.p. The effect is examined in detail, and it is shown that the conditions of impact are similar to those which govern the retardative effect of bilge keels in the rolling movement of ships. R. A.

ELECTRIC LAMPS AND LIGHTING.

949. *Industrial Plant Illumination.* **G. C. Keech.** (Elect. Rev., N.Y. 50. pp. 1051–1052; Discussion, pp. 1052–1054, June 29, 1907. Abstract of paper read before the Illuminating Engin. Soc., June 14, 1907.)—In this paper the importance of efficient shop lighting is emphasised by a test made on lamps lighting the face-plate of a drill, where the lamp installed gave 3·7 candle-feet, a new clean lamp gave 5·6 candle-feet and a very dirty lamp 1·55 candle-feet. Wiping the dust from a mercury vapour lamp and its reflector increased the illumination 12 per cent. It was found that the product of a shop working during night hours was increased 15 per cent. by a thorough overhauling of the lighting. The paper also includes several series of tests in which the same and similar rooms were lighted by a number of different illuminants, a very large number of readings being taken in each case. Mercury vapour lamps appear to be very satisfactory for use in printing-houses. C. K. F.

950. *Magnetite Electrode Arc Lamps.* **G. M. Little.** (Elect. Rev., N.Y. 50. pp. 982–984, June 15, 1907. Paper read before the National Electric Light Assoc., June 5, 1907. Abstracts in Electrician, 59. pp. 555–557, July 19, 1907. Elect. Engineering, 2. pp. 141–142, July 25, 1907.)—These electrodes, in addition to magnetite, always contain at least oxide of titanium and oxide of chromium, the titanium oxide rendering the arc luminous, the oxide of iron giving conductivity to the fused mass when cold, and the oxide of chromium preventing a too rapid consumption. These oxides, in a finely-powdered state, are tamped into a thin iron tube and the end sealed in an arc [see Abstract No. 572 (1907)]. They are burned as negatives with a metal anode, *e.g.*, copper or an alloy of metals whose oxides, when fused together, make a slag which is a good conductor when cold. The negative is arranged above, since the bright portion of the arc is near the surface of the negative electrode and a considerable amount of light is reflected from the surface of the pool of fused slag which forms on the negative electrode. An annular current of air is directed down around the negative carbon and arc, to carry off the volatilised oxides to a chimney so as to prevent them from condensing on the electrodes and on the reflector and globe. The lamp runs at 4 amps. and 65 to 68 volts at the arc. C. K. F.

951. *Brockie enclosed Arc Lamp.* (Brit. Pat. 16410 of 1906. Engineering, 83. p. 697, May 24, 1907. Abstract.)—Here the arc is completely enclosed in a chamber which excludes entirely the access of air to the arc. For this purpose, instead of allowing the carbons to pass through stuffing-boxes in the usual way, the chamber containing the regulating mechanism is made gas-tight and the globe is secured gas-tight to the under side of this chamber by means of mica washers. The carbon-holders each contain a number of carbons which apparently burn simultaneously. The upper carbon-holder is suspended by a cord from a spring drum, the spring of which is wound as the carbon-holder falls. The clutch is mounted on an arm pivoted coaxially with the spring drum and oscillated by the solenoid-core lever through a link. This clutch consists of a pawl engaging ratchet teeth on the spring drum and is tripped by a fixed stop so as to permit the feed to take place when the arm bearing it has fallen to a predetermined point by reason of the diminished pull of the series solenoid. C. K. F.

952. *Thomson-Houston Flame Arc Lamp.* (Elect. Engineering, 1. p. 1108, June 27, 1907.)—In this lamp, in which the carbons are arranged at an acute angle and are fed by gravity, the economiser cup is a metal casting containing a renewable fire-clay disc, and instead of using an electromagnet for shaping the arc a permanent magnet is employed forming part of the mechanical structure. The shunt magnets are wound with a wire having special enamel insulation. The original paper gives other details of the lamp and is well illustrated. C. K. F.

953. *Mean Horizontal Candle-power of Glow-lamps.* **E. P. Hyde** and **F. E. Cady.** (Electrical World, 49. pp. 1260–1268, June 22, 1907.)—Uppenborn [Abstract No. 887 (1907)] states that large errors arise when the m.h.c.p. is obtained by rotating glow-lamps. This is at variance with the deductions of the authors from their experimental results [see Abstract No. 826 (1907)]. Hence the authors were led to make further experiments by a different method. They first experimented on a 110-volt 16-c.p. oval anchored-filament lamp. It was rotated at 420 revs. per min. and readings were taken. Measurements were then made every 10° in a horizontal plane with the lamp stationary, and finally the lamp was again rotated and readings taken. If the first reading be denoted by 1·000, the second was 1·002, and the third 0·999. The differences therefore are within the limits of experimental error. A double filament lamp was next measured in the same way but at a speed of 350 r.p.m., and gave results 1·000, 1·005, and 0·999. The m.h.c.p. of another double filament lamp was found by the point-to-point method to be represented by 1·002. When rotated at 180 r.p.m. it was found to be 1·000 before the point-to-point measurements were made, 1·003 when the measurements were half made, and 0·998 at the end of the test. The double filament lamps were next rotated at speeds varying from 180 to 820 r.p.m., and measurements were taken. The max. decrease of m.h.c.p. was about 5 per cent. and occurred at 800 r.p.m. In this case the two filaments were each touching the bulb, one on one side and one on the other. Provided the filaments did not touch the bulb, the discrepancy was not as great as 1·5 per cent. When the filament touches the bulb it is cooled, and hence we might have anticipated a decrease in c.p. The fact that the current increases appreciably supports this view. Lamps were made similar to those on which Uppenborn experimented, but the decreases in m.h.c.p. due to rotation were not as great as he found. It was found also that the percentage

change in end-on c.p. cannot be taken as a criterion for determining the effect of rotation on the m.h.c.p. The authors point out the important effect of the flicker produced when some types of lamp are rotated on the accuracy of the observations. This difficulty is easily surmounted in practice by means of an auxiliary mirror. A. R.

954. *Photometry in Central Station Practice.* **R. McCourt.** (Elect. Engineering, 2. pp. 24–25; Discussion, pp. 25–27, July 4, 1907. Paper read before the Municipal Elect. Assoc., June 28, 1907. Electrician, 59. p. 510; Discussion, pp. 510–511, July 12, 1907. Abstract.)—In view of the great harm done to the electric lighting business by the large number of inefficient and wrongly-graded lamps on the market, a system of testing and certifying lamps is adopted at Harrogate. The procedure is as follows: The pressure having been exactly adjusted to the declared pressure, the lamps are put in the lamp-holder in turn and the power is read off by a dead-beat wattmeter. The lamps outside the watt-limits are rejected, and the remainder are passed to the photometer-room. One operator can do this test at the rate of 200 lamps per hour. The photometer head used is of the Bunsen disc type, and the scale is calibrated directly in candle-power, a standardised glow-lamp being used. A junior assistant can easily test for c.p. at the rate of 150 lamps per hour. The following table gives the limits of the c.p. specified:—

	100 Volts.		200 Volts.		Limits of C.P.
	Watts.	Watts per Candle.	Watts.	Watts per Candle.	
5 c.p.	26	4·2	28	4·5	4–6·5
8 c.p.	34	4	36	4·25	7–9
16 c.p.	66	3·75	68	4	14–18
25 c.p.	100	3·75	108	4	22–28
32 c.p.	130	3·75	140	4	28–36

The installing of a testing department has raised the quality of the lamps received for testing. In connection with outdoor photometry the Haydn Harrison portable photometer is described. A low-voltage "osram" lamp and a small portable accumulator are used for the light-standard. A. R.

955. *Comparison of Street Illuminants.* **K. Edgcumbe.** (Elect. Engineering, 2. pp. 5–11, July 4, 1907.)—Some notes are here given on the best methods of estimating the effect produced by any given system of street-lighting. The author favours the method suggested by H. T. Harrison, according to which the minimum illumination in a street is regarded as a criterion of the efficiency of the lighting, and considers that curves should be plotted showing the illumination in candle-feet along the middle of the street. The paper contains a number of these curves, taken in some of the London streets, some of which are lighted with gas and others with electricity. The paper also contains a large number of facts and figures connected with the relative advantages of the two systems of lighting. W. H. S.

956. *Resistivity and Temperature-coefficient of Tantalum.* **M. v. Pirani.** (Zeitschr. Elektrochem. 13. pp. 344–345, June 21, 1907. Electrician, 59. p. 599, July 26, 1907. Translation.)—The resistivity of tantalum has been given by

v. Bolton as 0·165 ± 5 per cent. and the average temperature-coefficient as 0·3 per cent. [Abstract No. 1098A (1905)]. Owing to the great variation in resistivity observed with different pieces of Ta when made incandescent *in vacuo*, the author has endeavoured to obtain a more definite and less variable value for the resistivity of pure Ta. For this purpose wires were taken whose resistivity varied more considerably from the mean (viz., four wires, of resistivity 0·178, 0·18, 0·175, 0·188). These were kept at about 1,900° in a very high vacuum for 100–200 hours. On these being removed and re-measured the resistivities were found to be 0·147, 0·145, 0·147, 0·145 respectively. Thus, while the individual values are very much more concordant, the mean value is much lower than that given by v. Bolton. The temperature-coefficient was found to have increased to 0·33 per cent. per 1° between 0 and 100°. Measurements from liquid-air up to ordinary temperatures give 0·32 per cent. per 1° as a mean. But taking the temperature of the metal lamp filament at 1·5 watts per candle as 1,750°, and since the resistance is then six times as great as at room temperatures, the temperature-coefficient can, it is considered, be taken as 2·9 per cent. in the mean (500 per cent. to 1,730°). The mean value for the resistivity of pure Ta should now be taken as 0·146, and the temperature-coefficient as 0·33 per cent. per 1°. The former lower values are held to be due to structural modifications produced by the drawing into wire.

L. H. W.

957. *Carbon Suspenders for Electric Lamp-filaments.* (Brit. Pat. 12,325 of 1906. Engineer, 103. p. 669, June 28, 1907.)—This patent of the Deutsche Gasglühlicht A.-G. relates to the employment of carbon suspenders in place of suspenders of metal or refractory oxides, in lamps with tungsten filaments. The carbon filament suspender is found to remain comparatively cool even when in contact with a white-hot metal filament, and can hence be made very thin. Although such suspenders cannot be used with osmium filaments, owing to the formation of a carbide, this objection does not apply in the case of tungsten filaments. L. H. W.

958. *Train-lighting.* **H. Henderson.** (Inst. Elect. Engin., Journ. 39. pp. 132–156; Discussion, pp. 156–168, July, 1907. Paper read before the Newcastle Section. Elect. Engin. 39. pp. 345–348, March 8; 381–384, March 15; 411–413, March 22, and pp. 452–454, March 29, 1907.)—Clear descriptions are given of the Stone, Vickers-Hall, Verity-Dalziel, Moskowitz, and Mather and Platt's (using Rosenberg's dynamo) systems. The author gives the annual cost of lighting an eight-compartment coach with two 10-c.p. lamps in each compartment for electricity, ordinary gas, and incandescent gas respectively as £11, £16 2s., and £8 12s. 1d. (including interest and maintenance). In the *discussion*, however, **J. Pigg**, from the experience of the London and North-Western Railway Co. with the Stone system, gives the actual figures deduced for 1,188 coaches, viz., £9 12s. 6d. per coach, made up of: interest, 62s.; maintenance, 110s.; fuel, 20s. 6d. The gas-lighting in these coaches, costing £15,150 per annum, was replaced by electric lighting costing only £9,792 per annum, a saving of about 41 per cent. of the gas installation. On the Brighton Railway maintenance cost has been found to be as low as 97s. 1½d. per coach. The **Author** points out, in reply, that the London and North-Western cost per coach does not include a complete equipment on each coach, as sometimes one dynamo supplies two coaches. L. H. W.

REFERENCES.

959. *Efficiency of Buffer Battery Plant connected to Alternating-current System.* **L. Schroeder.** (Elektrotechn. Zeitschr. 28. p. 620, June 20, 1907.)—The author summarises the results of tests carried out on a small buffer battery plant connected to an alternating-current generating station. The combined efficiency at full load, including losses in battery, comes out at 89 per cent. A. H.

960. *Central Station Supply Economics; their Study, and what it promises in the way of Cheaper Supply.* **A. M. Taylor.** (Inst. Elect. Engin., Journ. 39. pp. 364-386; Discussion and Communications, pp. 387-413, Aug., 1907. Paper read before the Birmingham Section. Abstracts in Elect. Engin. 39. pp. 266-269, Feb. 22; 309-311, March 1; Discussion, pp. 449-452, March 29, 1907. Electrician, 58. pp. 714-720; Discussion, p. 720, Feb. 22, and pp. 937-939, March 29, 1907.)—From the author's summary given below, it is easily seen that no short abstract is possible. [See also Abstract No. 1277 (1905).] Definition of terms—Running charge for coal, wages, repairs, &c., analysed and separated from standing charges—Division of charges in combined lighting and traction stations analysed—Charge per unit to consumer unaffected by internal diversity factor of power load—Effect of combined diversity factor of the traction, power, and lighting loads in reducing standing charges—Ideal load needed to warrant the offering of ideal terms for current—Storage provides us with such an ideal load—Conclusions.

961. *Reinforced Concrete Tower for Aerial Wires.* **F. W. Scheidenhelm.** (Eng. News, 57. pp. 476-478, May 2, 1907.)—Illustrations and description of tower 115 ft. high with anchorage tower 55 ft. high for a strain of 55 tons at a height of 38·5 ft. above its base. [See Abstract No. 344 (1906).] A. E. L.

962. *1,200-volt Continuous-current Railway.* (Electrician, 59. p. 415, June 28, 1907. From the "Railway and Engin. Review.")—A 1,200-volt continuous-current railway line, having a total length of about 70·5 miles, is in course of construction in California. The insulated conductor consists of an under-running third rail of special low-carbon steel, and weighs 22·4 lbs. per yard. Each car is to be equipped with four 75-h.p., 600-volt motors. To avoid any possibility of an excessive speed being reached by a slipping motor, voltage relays are to be provided across the motor terminals. A. H.

963. *Electric Accumulator Omnibuses in Philadelphia.* **H. Y. Haden.** (Electrical World, 49. pp. 1120-1121, June 1, 1907. Elect. Engineering, 2. p. 143, July 25, 1907.)—A description of a combined generating station and garage now being erected. The battery charging and handling methods are dealt with.

964. *The Mercury Arc and its Technical Applications.* **J. Polak.** (Elektrotechn. Zeitschr. 28. pp. 599-603, June 13; 651-656, June 27, and pp. 733-738, July 25, 1907. Paper read before the Elektrotechn. Verein, Karlsruhe.)—Reviews the development of the mercury arc lamp and its starting mechanism, and gives a comprehensive *résumé* of recent practical improvements and experimental researches. L. H. W.

965. *Verity and Worsley's Inclined Carbon Arc Lamp.* (Engineering, 83. p. 331, March 8, 1907. Abstract.)—This lamp is of the same type as Lewis' [see Abstract No. 210 (1907)]; in Verity's lamp, however, one of the carbons feeds on to an abutment, whilst the other carbon passes through an eye in the clutch-lever, whereby it is moved sideways to strike, regulate, and adjust the arc. C. K. F.

TELEGRAPHY AND TELEPHONY.

966. *Experimental Study of Lines and Telegraphic Apparatus.* **Devaux-Charbonnel.** (Soc. Int. Élect., Bull. 7. pp. 833–866, June, 1907.)—The author continues the investigations which formed the subjects of Abstracts Nos. 1106, 1107 (1906), and 463 (1907). The present paper deals exhaustively with the phenomena attending transmission of currents through apparatus of well-known firms, and then of the transmission through the whole circuit comprising the line and the apparatus. Experimental research is conducted by aid of the oscillograph. The time of the excursions of the armatures from rest to working contacts is calculated for several instruments, and their suitability for high-speed service is in this way compared. In this connection the author distinguishes between the actual time occupied in making the first contact with that necessary for the definite flow of current in the local circuit, the times being necessarily different owing to the rebound experienced by the armature from its momentum on first impact. These times also vary with the strength of the current used for the permanent working of the apparatus. For the armature of the Baudot relay the following relations hold :—

Current in Milliamps.	Transit, Sec.	Definite Contact, Sec.
50	0·0025	0·012
20	0·0039	0·017
7	0·025	0·025

A greater degree of sensibility is, however, attainable. Curves are given showing the effect of the self-induction of the electromagnet, and the influence of the armature in its movements upon this property. In the specimens examined the self-induction of the electromagnet varied between 1 and 2 henrys. This is the normal value without taking into account the effect of the armature in its different positions. For a fine adjustment the author finds that this effect is small. The author next affords data of the Morse instrument. Removing the cores, the self-induction is 0·91 henry; with the cores, and the armature raised above the normal position, 12 to 22 henrys; armature normal, 14 to 25 henrys; armature sticking, 20 to 30 henrys. These values are widely different owing to the variation in the qualities of the iron employed in different specimens. The time of functioning depends upon the current employed. With 50 milliamps. the observed time is 0·008 sec.; with 18 milliamps., 0·085 sec. An interesting comparison is made between the Morse and the Baudot :—

	R.	L.	L/R.	Sensibility.	T. in Secs.
Morse.....................	500	25	0·05	15	0·02
Baudot	200	1·6	0·008	8	0·0006

When the line is added in circuit with the apparatus other considerations than those above dealt with enter into the problem. If isolated in space, a current-wave would be propagated through the wire with the speed of light. But this is modified by the surrounding medium and by other bodies in the vicinity; the velocity is given by the formula $V = 1/\sqrt{\gamma\lambda}$, γ and λ being

the capacity and the self-induction per unit length. The values determined for copper and for iron respectively are 285,500 and 186,000 km. The wave arrives at the extremity of the line at the end of a time—

$$\theta = L/V = L\sqrt{\gamma\lambda} = \sqrt{C\,L},$$

C and L being the capacity and the self-induction of the whole line. The passage of the wave is not indicative of the immediate establishment of a permanent current of finite value; the wave is reflected backwards and forwards with diminishing amplitude in times regularly increasing according to the progression 3θ, 5θ, 7θ, &c. The form of the current curve, however, depends also upon the value of a coefficient δ, whose value is—

$$\delta = (2\pi/R)\sqrt{(L/C)}.$$

If this coefficient is between 0 and 1·46 the current of arrival does not present abrupt variations, but manifests itself with a value inferior to that of the permanent state, and continues to increase slowly and regularly to this value. The following figures illustrate this statement :—

δ.	Current of Arrival.	First Variation.	Second Variation.	Current of Departure.
0·5	0·05	—	—	12·56
1	0·54	—	—	6·28
1·46	1·00	—	—	4·30
2	1·29	0·06	—	3·14
3	1·44	0·18	0·024	2·10
3·1416	1·45	0·20	0·024	2·00
4	1·34	0·30	0·052	1·50
8·6	1·00	0·48	0·23	0·74
10	0·92	0·48	0·24	0·62
20	0·52	0·36	0·23	0·30

Lines which are not homogeneous, but whose sections are composed of both iron and of copper wires, of varying lengths and diameters, and which also include cables, are difficult to deal with as a matter of calculation, and their properties are better studied experimentally. The author gives the following figures relating to δ, θ, and the time of attainment of the permanent state for composite circuits as well as one of copper only :—

	δ.	θ.	Permanent State. Baudot.	Permanent State. Morse.
500 km., of which 350 are of iron...	1·35	0·0034	0·010	0·022
250 ,, ,, 180 ,, ...	1·32	0·0022	0·007	0·021
1,000 ,, of copper of 5 mm. diam....	1·34	0·0048	0·010	0·025

In these particular cases, and possibly in others, although the author does not recommend, without caution, its application universally, the empirical formula here given applies—

$$\theta_1 = \theta + 3L/4R.$$

This gives the time of duration of a signal, and from this the speed of transmission may be deduced. For a line 500 km. long and of iron, with a Baudot relay, the duration of a signal would be 8·9 millionths of a second, hence 112

signals per sec. could be transmitted ; for a similar line of copper, the figures would be 7·8 and 187 respectively. The author now considers the values of the high-speed telegraphs of Siemens and Halske, of Pollak-Virag, and of Rowland, in regard to the above conditions. In the apparatus of the first-named the receiver has very small self-induction, which is favourable to high speed, but on long circuits likely to be more disturbed, for this reason, by induced currents from other lines. The author, however, sees no reason why on a copper circuit of 1,000 km. in length the duration of signal need be more than 0·005 sec., and that a rate of 200 signals per sec. might be maintained. The apparatus of Pollak-Virag is of a special character. It will be remembered that the receiver is a telephone, whose membrane is put in motion by the fluctuations in the current strength. The self-induction is about 50 millihenrys, and the duration of a signal on the above circuit 0·0023 sec. The mechanical inertia is, in addition, so small, that 400 signals per sec. could easily be transmitted. In the Rowland the speed of transmission is only limited by the mechanical inertia of the receiving relay, owing to the principle adopted in making use of alternating current. The future of telegraphy, according to the author, at high speed, appears to reside in the diminution of the importance of the receiver, either by reduction in the time-constant, as in the case of the Baudot and the Siemens' systems, or by its complete suppression from the electrical point of view, as in the alternating-current system of Rowland. The chemical receiver, in which an electromagnet is dispensed with, is yet another interesting attempt to reduce the duration of a signal to that of the variable state of the line only, which is a very feeble quantity. E. O. W.

967. *Carbonnelle's Téléautograveur.* (Rev. Électrique, 7. pp. 335–338, June 15, 1907.)—A short history of the work done by previous inventors [see Abstract No. 465 (1907)] is first given. One of the latest essays, that of H. Carbonnelle, on the line Brussels–Antwerp, is then described. He contrives to transmit designs and characters in the following manner : The transmitter is of the usual type. A point, electrically connected to the line, is caused to traverse a sheet of foil containing the matter that is to be transmitted. The sheet of foil is laid over a cylinder, grooved helicoidally. The point or style meets with insulated and non-insulated parts, and suitable current-impulses pass to line when the latter are encountered. The receiver consists of a telephone, whose membrane or diaphragm carries a steel point bearing upon a cylinder, covered with a sheet of a plastic substance or of a soft metal or of carbon papers, separated by white papers. The style at the receiving station will move in sympathy with the contacts made by the style at the sending station. The inventor can therefore produce an engraved impression or a multiple copy in carbon. The latter method is suitable in cases where only a few copies of the reproduction are necessary. The former is, however, capable in a printing press of affording a large number of copies. Further, for extensive reproduction, electrotypes can of course be obtained. A specimen of a print produced in this way is given in the paper. The inventor proposes to effect the preparation of half-tone plates by the following among other methods: (1) By reticulation of gums or bichromated gelatine. (2) By the principle of heliogravure. (3) By the use of metallic salts. (4) By carbon photographs. In the two first cases spots or stains of gum, gelatine, or bitumen are applied to the conducting support, proportionally to the shades of the photographic subject. In the third case the envelope of gelatine is of uniform thickness, but the metal is mixed or reduced in it in

various proportions, and renders the envelope at different points more or less conducting. In the fourth case the resistance of the pigmented envelope is proportional to its thickness, which varies with the lights or half-tones. The time of transmission is important. Between Brussels and Antwerp a portrait measuring 9 cm. × 18 cm. was transmitted in 80 sec. Written messages can be photographed in reduced size at a speed, according to the inventor, of 500,000 letters per hour. E. O. W.

968. *Electric Wave Propagation.* J. E. Taylor. (Elect. Rev. 60. pp. 659–662, April 19; 698–699, April 26; 743–744, May 3, and pp. 781–782, May 10, 1907. Paper read before the Inst. of Post Office Elect. Engin. (Metropolitan Centre), Jan. 11, 1907.)—Develops the theory of electric wave propagation on the basis of the conception of lines of strain in the ether. These lines are capable of annulling each other or fusing with each other, and the author gives a theory of wave-guidance and conductivity based upon such fusion. Dealing with wireless telegraphy, the author maintains that the vertical wire at a receiving station obstructs the advancing wave primarily in virtue of the "molecular fields" in its mass, but mainly in virtue of the electric field which the primary action builds up about the wire. It therefore abstracts some portion of the wave energy from the ether for a certain distance round itself, that distance not exceeding one-quarter wave-length. Of the energy abstracted from this region a portion not exceeding 50 per cent. may be made available for operating the detecting appliance. There is no actual "cutting" of the conductor by the magnetic lines because they never reach it. The cutting is a purely mathematical conception. Criticising the electronic theory, the author urges that it is apt to lose sight of the all-important functions of the dielectric medium. E. E. F.

969. *The Arc Method of producing Electric Oscillations.* L. W. Austin. (Bureau of Standards, Bull. 3. pp. 325–340, May, 1907. Elect. Engineering, 2. pp. 133–135, July 25, 1907. Electrician, 59. pp. 682–686, Aug. 2, 1907. Abstracts. Écl. Électr. 52. pp. 133–138, July 27, 1907.)—An experimental investigation of the conditions for the production of oscillations by means of an arc placed (1) in air, (2) in hydrogen, (3) in steam, (4) in compressed air. In air the arc was formed (240-volt circuit) with electrodes of solid carbon, cored carbon copper, graphite, and copper as anode with carbon kathode. In all cases oscillations of frequency 100,000 per sec. were obtained, thus confirming Salomonson's results [Abstract No. 161A (1904)], but only in the case of graphite electrodes were steady conditions obtained. The frequency as calculated in one experiment was 260,000, but measured by the secondary resonance well-marked maxima corresponding to frequencies of 295,000, 580,000, 910,000 were found; the lowest frequency carries the largest part of the energy. Curves are given showing the effect on the frequency of changing the resistance in the main circuit, and others showing the effect of using 120 volts instead of 240, and of using two arcs in series. A resistance of 1 ohm added in the shunt circuit, of resistance 7 ohms, destroyed the oscillations, while ½ ohm reduced them to about half. With the arc in hydrogen Poulsen's results, that more powerful oscillations can be obtained by this means, were confirmed. The increase in the energy which can be drawn from the oscillating circuit is remarkable. Large resistances can be placed in the secondary coupled circuit (as before, not in the oscillatory circuit itself), and in this way 100 watts and more can be absorbed as against 6 or 8 watts with the graphite arc in air. The presence of hydrogen has a bad effect on the sharpness of tuning, but the beneficial effect as regards output is not fully

explained. With steam all the effects observed with the arc in hydrogen were obtainable, powerful oscillations being also obtained when the arc was formed under water. Coming now to the quite novel experimental results obtained with the arc in compressed air, in which the suggestions of Fessenden and of Simon are applied, the source of current was a set of ten small 500-volt, direct-current dynamos in series, capable of giving 0·15 amp., and with a fixed resistance of 30,000 ohms in series. A Fessenden compressed-air condenser of capacity 0·0044 mfd. was in the shunt circuit with an inductance of 0·009 millihenry. The data of a typical experiment are reproduced.

Air pressure in arc	6·8 atm.
Electrodes, silver	0·8 mm. thick.
Direct current without oscillation	0·15 amp.
„ with oscillation	0·11 „
P.d. of arc without oscillation	90 volts.
„ with oscillation	2,000 volts.
P.d., open circuit	4,500 „
Arc length	0·4 mm.
Alternating current	11·5 amps.
Frequency	850,000.

The rise in arc p.d. when oscillations occur is thus more marked even than with hydrogen. It is found that resistances of several hundred ohms may be introduced direct into the oscillating circuit without detriment. No frequency besides the fundamental was found, and no change of frequency when either the direct current was reduced to less than half by means of resistance or the arc length was varied. As regards the efficiency of the arrangement, with 300 watts (about) as the available power (supplied) to the arc, 200 watts were obtained in the shunt circuit at a frequency of 650,000, an efficiency of 60 per cent., 180 watts at 1,500,000 and 140 watts at 3,500,000; at 4,500,000 the oscillations became irregular. The increase in the oscillations produced by increase of air pressure is shown in a curve plotted between pressure in atmos. and oscillatory current in amps. For pressures of 2, 3, 4, 5, 6 atmos. the corresponding current values are 2, 6·3, 10, 11·6, 11·95 amps., at frequency 850,000. It is considered that there is a point above which the arc breaks up into successive sparks, and that the compressed air high-potential arc is not continuous. The damping coefficient in one case was found to be about 0·1 per period. L. H. W.

970. *Use of a Non-earthed Closed Circuit as Receiving Circuit in Wireless Telegraphy.* **G. W. Pickard.** (Elect. Rev., N.Y. 50. pp. 985–986, June 15, 1907. Elect. Engineering, 2. pp. 54–55, July 11, 1907. Electrician, 59. pp. 563–564, July 19, 1907. Abstract.)—The author gives the results of some experiments which he has made with a closed circuit, including a condenser for tuning purposes, which is not earthed and is placed so as to make use of the magnetic component of the transmitted radiation (*i.e.*, placed with the plane of the loop in the common vertical plane joining transmitter and receiver). Good signals were received from the South Wellfleet (Mass.) Marconi station, about 90 miles distant, the silicon detector of the author being used as detector. When adjusted for max. response the intensity, measured by the method described in Abstract No. 228 (1907), was found to be approximately 0·01 erg per dot. No alteration in the tuning or the intensity was observed when any part of the rectangle was earthed, so that no portion of the received energy

apparently comes from the electric component of the transmitter radiation. The inductance of the rectangle was 0·106 millihenry, and when in tune with Wellfleet the condenser capacity was 9,000 micro-mfd. (0·009 mfd.), giving a frequency of 168,000, which is very approximately that of the Wellfleet station. A larger rectangle, of 0·187 millihenry, received 0·06 erg per dot from Wellfleet. The loop is found to have a marked directive property, the strength of signals becoming zero when the transmitter radiation comes from a direction at right angles to the plane of the loop; the null point is very sharply defined. It is suggested that such a loop could be used as a direction finder by making the loop rotatable and finding the null point.

L. H. W.

971. *Wireless Telegraphy during Daylight.* **R. A. Fessenden.** (Electrician, 59. p. 604, July 26, 1907.)—The writer of this letter claims that, by means of a different type of impulse [not described as to its nature or production], the absorbing power of daylight has been cut down to a small fraction of its previous amount. The new impulses are stated by the writer to be somewhat less efficient during night-time than the old ones at shorter distances (400 miles); above 1,500 miles the intensity with the new impulse also falls off from the intensity at night, but to a different order. Using the new method, working between Brant Rock, Mass., and the West Indies has been successfully carried out (about the same distance as between Newfoundland and Ireland). L. H. W.

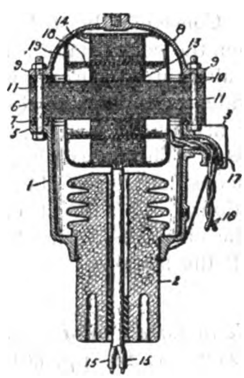
972. *Inductive Disturbances in Telephone Lines.* **L. Cohen.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 765–777, May, 1907.)—This is a mathematical paper, the principal part of which cannot easily be abstracted, designed to show the effects of electrostatic and of electromagnetic induction between parallel wires. J. J. Carty had argued in 1891 that the electromagnetic effect is entirely negligible as compared with the electrostatic effect. The mathematical deductions serve to show that this conclusion is not generally applicable. The author takes the case of two parallel lines grounded at their extremities, one of which is subject to an alternating e.m.f. and the other a telephone line, and supposes the two wires to be 1·25 cm. apart, and at about 1,000 cm. above the ground, the radius of each wire being 0·1 cm. Applying his formula, it is shown that the ratios of the two forms of induction for the various lengths of lines given below are—

l	$\frac{e.s.}{e.m.}$
0·1 km.	0·02
100 km.	0·44
1,000 km.	1·6

From this short table it will be seen that for the particular case under consideration the electromagnetic induction is far larger than the electrostatic; but as the length increases the electrostatic is gaining more rapidly than the electromagnetic, and thus at 1,000 km. the electrostatic has overpowered the electromagnetic. In obtaining the above results it is assumed that the line has no telephone receiver in it, which is, of course, not the case actually. In the case of a long line, however, say 100 km. or more, where the inductance of the line is large compared with the inductance of the receiver, the introduction of a receiver will not modify the result to any great extent, but in the case of a short line the introduction of one or more receivers may affect the results to a very great extent. Consider for example one of

Carty's experiments. There are two lines of about 0·1 km. long stretched side by side at a distance of about 1 cm. and there are three telephone receivers in the second line; the complete solution of this problem is not of course so simple, yet, as an approximation, the introduction of the telephone receivers may be considered, in such a short line, as a distributed inductance and resistance. If the inductance of each receiver is 0·05 henry and its resistance is 50 ohms, then for such a short line, the inductance per unit length will be L = 1·5 henry and R = 150 ohms. Assuming these to be the constants of the line, it is found, on calculating as in the previous cases, that the current due to electromagnetic induction is practically zero, and it is only the current due to electrostatic induction that has any appreciable value, and this is what Carty obtained experimentally. To infer from this that electromagnetic induction is negligible in all cases is, however, certainly incorrect. In the case of a long line, say 500 km., the induction and resistance of the telephone receivers will not modify to any great extent the constants of the line, and in that case the electromagnetic induction is just as important as the electrostatic induction. Which is the more important depends a great deal on the length of the lines, their height above the ground, and their distance apart. By varying any one of the above factors we shall vary the ratio of the electromagnetic to the electrostatic induction. E. O. W.

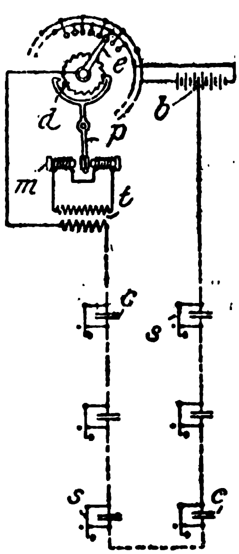
973. *Protecting Telephone Lines from High-potential Transmission Lines.* (West. Electn. 40. p. 572, June 29, 1907.)—The inventor, J. J. Frank, points out that in modern high-tension transmission practice it is common custom to connect the various stations and power-house of a system by telephone.



Frequently the telephone wires are carried on the poles which carry the high-tension transmission wires, and unless some means of protection is provided an accidental contact between the two sets of wires is liable to result fatally to a person using the telephone, or at least cause serious damage to the apparatus. The telephone transformer shown in the Fig. was designed to afford such protection. The adjacent punchings of the core are reversed with respect to each other. The core has a low magnetic reluctance, due to the large overlap of the E-shaped members that compose it, and consequently requires only a small magnetising current, so that only a small current is needed for ringing; while by forming the laminations of high-resistance steel, losses are relatively small with the high-frequency talking currents. If desired the frame (1) may be earthed. E. O. W.

974. *Radio-telegraphic Convention.* **F. Braun, G. G. Arco.** (Electrician, 59. pp. 565–566, July 19, 1907.)—Criticisms on the Convention. Braun disputes Fleming's claim that wireless telegraphy is impossible without employing an earthed antenna, which Fleming says was first disclosed by Marconi. Arco considers that, in agreement with Preece's views, no difficulties will occur if the "continuous" oscillations are adopted in practice. He refers to the inefficiency of the arc method, and states that practical tests have proved that the damped and "undamped" stations can work with one another, by using an interrupter in the receiving circuit as first proposed by Tesla (Brit. Pat. 11,298 of 1901) and now called by Poulsen the "ticker" connection. L. H. W.

975. *Electric Telegraphs.* (Elect. Engin. 40. p. 89, July 12, 1907.)—The following device is by Siemens and Halske. Alternating currents, which may be used to work step-by-step printing telegraphs, are converted from direct by opening one of the switches S which normally short-circuits the condenser C at each station. The direct current which charges the condenser causes a current to be induced in the secondary winding of the transformer *t*, which effects a movement of the polarised armature *p* and ratchet wheel *d*. The reversal of the battery potential so produced causes the recharge of the condenser in the opposite sense, and a further induced current in the circuit of the electromagnet *m*. Consequently, so long as the switch S remains open, the commutator arm *e* continues to rotate, and an alternating current is supplied to the line and condensers. The re-closing of the switch brings the armature *p* to rest, and the alternating current ceases. The alternating impulses cause the simultaneous rotation of the type wheels at the various stations. The direct current which replaces the alternating current when the circuit is again closed effects the printing of the selected character at all the stations. E. O. W.



976. *The Telephone Cable in Lake Constance constructed with Pupin Coils.* **Ebeling.** (Elektrotechn. Zeitschr. 28. pp. 661–667, July 4, 1907. Paper read before the Elektrotechn. Verein. Engineering, 84. pp. 85–86, July 19, 1907.)—This cable has been previously referred to in Abstract No. 1481 (1906). The present is a full account of the construction and the laying of the cable, which were not accomplished without care and difficulty. The coils are enclosed within the lead sheath. The conductors have a section each of 1·77 mm.² The guaranteed ohmic resistance was not to exceed 20 ohms per km. of double conductor, and the coils were to be of the same value, making the combined resistance 40 ohms. The actual result is 38·5 ohms. The capacity stipulated for as a maximum was 0·05 mfd. per km., but actually obtained 0·039. For the self-induction the figures similarly (per km. of double conductor) are 0·20 and 0·21 henry. With alternating current of 900 periods β was to be 0·01, and by actual measurement after manufacture it was found to be 0·0072. The author gives the following

formula as applicable to this cable: $\beta = (R/2)\sqrt{(C/L)}^{10^{-3}}$. To form comparisons with other cables, specially constructed for the telephone, the following figures are useful [see also Abstract No. 2092 (1904)]:—

No.	Cable.	Construction.	Capacity.	Self-induction.	Resistance.	Damping Factor.	Cu.	Diameter, Cu.
			Mfd.	Henry.	Ohm.	β.	mm.².	mm.
1	Refsnaes - Soelvig	Guttapercha 3 iron wires 0·2 mm. diameter.	0·12	0·0087	4·55	0·0084	8·6	3·3
2	Fehmarn-Laaland	Lead-covered iron wire 0·3 mm.	0·082	0·0050	5·34	0 0105	10·0	3·6
3	Cuxhaven-Helgoland	Lead-covered iron wire 0·3 mm.	0·044	0·0043	3·80	0·0065	12·6	4·0
4	Friedrichshafen-Romanshorn	Pupin-cable	0·039	0·21	33·5	0·0072	1·77	1·5

The three first cables have their conductors overlaid with spirals of iron wire [Abstract No. 2698 (1904)]. The author calls attention to the small amount of copper used in the latest cable, No. 4, as compared with No. 3, and he considers that nothing has been sacrificed in efficiency. The possibility of making and of laying a cable of the new type in water of a depth of 250 m. has been proved, and the author considers that the result is successful.

E. O. W.

977. *Telegraph and Telephone Circuits as affected by High-voltage Transmission Lines.* F. Schrottke. (Elektrotechn. Zeitschr. 28. pp. 685–689, July 11, and pp. 707–712, July 18, 1907.)—The telephone lines which are provided on all high-voltage transmission lines are subject to very powerful electrostatic induction effects, the exact magnitude of which depends on the position of the line (which determines its capacity relatively to the transmission wires and to earth) and on its insulation. The greatest disturbance arises when one of the transmission wires develops an earth. If the telephone (or other) line be connected to earth through resistances, a current will flow which reaches its maximum value when the earthing resistance is made negligible. The electrostatic induction effect decreases with increasing distance between the line affected and the power transmission line, but as the decrease follows the logarithmic law, the disturbing effect extends to a considerable distance. Other things being equal, a three-phase transmission line exerts a larger disturbing effect than a single-phase line. Contact with a telephone line which is carried on the transmission line poles is as a rule attended with danger to life. A number of examples are worked out by the author in illustration of the above statements, and formulæ are deduced for calculating the capacities of the lines in various cases. The disturbances may be reduced by artificially increasing the capacity to earth of the line affected, by providing guard-wires (which, however, must be very numerous to be effective), by transposition of the wires forming both lines (a method which, though effective when the conditions of operation are normal, breaks

down if one of the transmission wires becomes earthed), and by the use of a lead-sheathed *cable* for the telephone line. This latter method the author has experimentally found to be by far the most effective, and he strongly urges its adoption. The cable is supported by hangers from a bearer wire which at the same time serves to connect the poles to the earthing wires.
A. H.

REFERENCES.

978. *Kilroy's System of Electrical Danger Signals for Warship Turrets.* (Engineering, 83. pp. 612–614, May 10, 1907.)

979. *A Selective Wireless Telegraph Method.* **I. Hettinger.** (Elect. Engin. 39. pp. 860–862, June 21, 1907.)—An abbreviation of the author's patent specification (No. 4,965 of 1906). The method is based upon the fact that the ratios of any two values on the resonance curve corresponding to different free frequencies of the receiving oscillatory circuits does not change although the energy received and hence the actual amplitudes may have very different values. On this basis a solution of the problem of selectivity is aimed at and a differential arrangement put forward which claims to attain this object. This is extended to the case of multiplex telegraphy, in which case no less than twelve detectors tuned to different frequencies are proposed. L. H. W.

980. *Radio-telegraphic Station with Continuous Waves.* **A. Montel.** (Elettricista, Rome, 6. pp. 193–198, July 1, 1907.)—The author gives the equations for the calculation of a station in which an arc is used as generator, in as exact form as is possible, considering the extent of our knowledge of the subject. Numerical examples are worked out in every case, including examples of loose and close coupling. As the paper is itself much condensed, and consists almost entirely of mathematical and arithmetical calculations, it is impossible to do it justice in an abstract. J. E.-M.

981. *Clark Portable Wireless Telegraph Set.* **A. F. Collins.** (Elect. Rev. 61. pp. 156–157, July 26, 1907.)—Used by the U.S. Signal Corps. No special electrical features. L. H. W.

982. *Radio-telegraphic Convention.* (Elect. Rev. 61. pp. 116–118, July 19, 1907. Report of Committee of the House of Commons.)—The Committee recommend the adhesion of this country to the Convention. (Ibid. pp. 118–119.)—An abstract of memorandum by C. Bright.

983. *Telephone Line Construction.* **S. P. Grace.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 495–521, April, 1907. Elect. Engineering, 2. pp. 146–148, July 25, 1907. Abstract.)—The author enumerates the most important problems in connection with the wire plant.

984. *Theory of Resonance Transformer.* **C. Breitfeld.** (Elektrotechn. Zeitschr. 28. pp. 627–628, June 20, 1907.)—Theories of the resonance transformer—*i.e.*, of a transformer whose secondary is connected across a condenser—have been given by Seibt [Abstract No. 2404 (1904)] and Benischke [Abstract No. 188 (1907)], in each case on certain simplified assumptions. The author considers the most general case, taking the resistances of the windings into account, and shows that resonance conditions for the two circuits are not reached simultaneously. A. H.

SCIENCE ABSTRACTS.

Section B.—ELECTRICAL ENGINEERING.

SEPTEMBER 1907.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

985. ***Multiple-stage Steam Turbines of the Impulse Type.*** **H. Wagner.** (Zeitschr. ges. Turbinenwesen, 4. pp. 289–292, July 10, 1907.)—In the more recent designs by the firms exploiting the impulse type of steam turbine it is apparent that there is a decided tendency to decrease the number of stages, and consequently the number of wheels, to the utmost limit that considerations of economic steam consumption permit. Thus in the case of the Rateau turbine, the older designs, even for outputs of less than 500 kw., had some 25 wheels and a corresponding number of pressure steps. Quite aside from theoretical considerations, this large number of wheels was chosen from considerations of a practical nature, such as the avoidance of exceedingly high peripheral speeds with the high friction losses and expensive mechanical constructions associated therewith. In the newer designs with higher peripheral speeds and a smaller number of pressure stages, the machine is of considerably shorter over-all length, and a more favourable design for the bearings is obtained. The works' cost of such a machine is also considerably decreased. The decrease in the number of stages has been associated with an increase in the number of blades per wheel. Thus, in one of the earlier designs for a 1,000-kw. 25-wheel Rateau turbine with a wheel diam. of 1,150 mm., there were 240 blades per wheel; each blade had a width of 30 mm., and the peripheral speed was 95 m. per sec. In a more modern impulse turbine of equivalent capacity there are only some 8 or 10 stages; the wheel diam. is some 820 mm., the peripheral speed some 120 m. per sec., and there are from 180 to 250 blades per wheel. The evolution of the impulse type of turbine is tending toward a uniform design. Whereas formerly great differences of opinion existed with regard to the shape of the blade, the blade pitch, and the width of the blade, much better agreement as regards the proper quantities for a given case is now found. The width of the blade seldom exceeds 25 mm., even in the low-pressure wheels of very large turbines. The axial clearance between the stationary and rotating part is in all multiple-stage turbines very liberal, and lies between the limits of 3 and 6 mm. In the Zoelly turbine the number of stages has been decreased in recent designs to from 7 in the smaller sizes to 14 in the larger sizes, and the peripheral speeds

have been correspondingly increased. This is also the case in the newer designs of the Rateau type; for instance, in the Rateau turbines built by the Oerlikon Co. The most extreme decrease in the number of pressure stages is exhibited in the designs of the A. E.-G. of Berlin. Up to outputs of medium size this Company employs only two pressure steps each with two speed steps, and only in the larger sizes are greater numbers of stages employed.

H. M. H.

986. *Determination of Calcium in Boiler Feed-water.* **F. E. Hale.** (Amer. Chem. Soc., Journ. 29. pp. 1078–1085, July, 1907.)—The determination of the calcium in boiler feed-water is of importance, since the difference between this test and that for total hardness gives the amount of magnesium present. The method described by the author is based upon the precipitation of the calcium as oxalate in a slightly acid solution and the volumetric determination of the oxalic acid radical in the precipitate by means of a solution of potassium permanganate. The method has been tested under various conditions as regards the presence of other salts and impurities, and has been found accurate. It is rapid and well suited for routine work. The calculation of the results when the (1) alkalinity, (2) total hardness, and (3) calcium content of the water have been determined, is next discussed by the author. The procedure recommended is to calculate the alkalinity expressed as carbonate, to calcium, and if the amount of calcium actually found by test (3) is less than that required by test (1), to calculate the remaining portion of the carbonate as magnesium carbonate. When the alkalinity test is less than the calcium or than the calcium + magnesium, the excess of these two elements is calculated out as sulphate. The author summarises his results as follows: The method described is admirably suited for the routine analysis of a large number of samples, and may be considered accurate to two parts per million. It is applicable to all quantities of calcium occurring in natural waters, and is equally accurate with large or small quantities of calcium. In combination with the total hardness test it furnishes a rapid method of determining the total magnesium present in the water.

J. B. C. K.

987. *Unbalanced Forces in Multi-cylinder, One-crank Engines.* **A. Sharp.** (Inst. Civil Engin., Proc. 168. pp. 235–251, 1906–1907.)—These forces are investigated algebraically and by a graphical method and applied to several examples of different arrangements, some numerical results being given. Exact expressions for the acceleration of the piston and of the connecting rod at any instant, or Klein's exact graphical constructions, may be taken as the basis of the investigation, but it is more convenient to take the expression for the acceleration in terms of the cosines of θ, and even multiples of θ, the angle through which the crank has revolved from its initial position. Uniform angular speed of the crank is assumed, but reference is made to J. H. Macalpine's paper (Engineering, Oct., 1897) on the influence of variation of the angular speed on the acceleration of the reciprocating masses. The examples taken for the application of the investigation are those of two cylinders at 90°, three cylinders at 60°, three cylinders at 120°, an even number (6) of cylinders at equal angles, and an odd number (5) of cylinders at equal angles. The results for these examples are given in the table on opposite page; in each case the epoch-angle is stated in the first line, the expression for the unbalanced force or couple in the second, and the numerical values for the data assumed in the examples in the third line of each division of the table.

F. J. R.

	Position of Reference Line OX.	Unbalanced Forces.					Transverse Couples.		
		Primary.	Second Order.		Fourth Order.		Primary.	Third Order.	Fifth Order.
		Reverse.	Forward.	Reverse.	Forward.	Reverse.			
Two cylinders at 90° ...	Bisecting angle 90° between cylinders	0	0° $\frac{1}{\sqrt{2}}Amq$ 110 lbs.	180° $\frac{1}{\sqrt{2}}Amq$ 110 lbs.	0° $\frac{1}{4\sqrt{2}}Amq^3$ 1·1 lb.	0° $\frac{1}{4\sqrt{2}}Amq^3$ 1·1 lb.	0° $\sqrt{2}TIq$ 99·7 lb.-ft.	0° $\frac{8\sqrt{2}}{8}TIq^3$ 2·1 lb.-ft.	0° $\frac{15\sqrt{2}}{128}TIq^5$ 0·002 lb.-ft.
Two cylinders at 180°...	Axis of cylinder	0° Am 782 lbs.	0	0	0	0	0	0	0
Three cylinders at 60°...	Axis of middle cylinder	0	0° Amq 156 lbs.	180° $\frac{1}{2}Amq$ 78 lbs.	0° $\frac{1}{8}Amq^3$ 0·78 lb.	180° $\frac{1}{4}Amq^3$ 1·56 lb.	0° $2TIq$ 141 lb.-ft.	0° $\frac{3}{8}TIq^3$ 1·1 lb.-ft.	180° $\frac{15}{128}TIq^5$ 0·008 lb.-ft.
Three cylinders at 120°	Axis of a cylinder	0	0	0° $\frac{3}{8}Amq$ 284 lbs.	180° $\frac{3}{8}Amq^3$ 2·8 lbs.	0	0	180° $\frac{9}{8}TIq^3$ 8·2 lb.-ft.	0
Five cylinders at 72° ...	Axis of a cylinder	0	0	0	0	180° $\frac{5}{8}Amq^3$ 8·9 lbs.	0	0	0° $\frac{75}{128}TIq^5$ 0·007 lb.-ft.
Even number of cylinders, greater than two, at equal angles	—	0	0	0	0	0	0	0	0

988. *Compound Piston Drop-valve Engine.* (Engineer, 104. pp. 54–56, and Supplement, July 19, 1907.)—This is a vertical inverted compound steam engine recently installed at the electric power station of the Huddersfield Corporation, the main features of the engine consisting of the balanced piston drop-valves and gear. Illustrations of the piston valves are given from photographs of the valve in different positions, with sectional elevations, plan, and (in a supplement) photographic views of the engine. The makers of this engine, Cole, Marchant and Morley, Ltd., have overcome the objection of uneven wearing hitherto urged against the piston drop-valves. The drive for the valve gear is taken by an inclined shaft from helical gear on the main shaft to helical gear on a long shaft on the platform, thus abolishing the use of eccentrics on the main shaft and rendering the arrangement more compact. The cylinders are 24 and 48 in. diam. by 42 in. stroke, and the engine runs steadily at 100 r.p.m. Boiler pressure, 160 lbs. max.; superheat, 100° F.; diam. of flywheel, 17 ft. 2½ in.; weight, 84 tons. Weight of armature, 81,000 lbs. Diam. and stroke of air-pump, 34 in. by 14 in. F. J. R.

989. *Steam Turbines and Turbo-generators.* **F. Niethammer.** (Elektrotechnik u. Maschinenbau, 25. pp. 565–571, July 21, and pp. 586–591, July 28, 1907. Paper read before the Berg- u. Hüttenmännscher Verein, Mähr.-Ostrau, June 8, 1907.)—The author reviews modern methods of construction for steam turbines and turbo-generators. Illustrated descriptions are given of the various methods of fixing the blades of turbines. One of the most frequent causes of blade-stripping is the unequal expansion of the turbine rotor when the turbine is heated up while at rest before starting. Such unequal expansion causes a bending of the rotor shaft. For this reason the author recommends that, during the 5 to 15 minutes required to heat up the turbine, the rotor should be allowed to run slowly (at about $\frac{1}{10}$th of its normal speed), by the use of either steam or an auxiliary motor. The various types of condensers used in connection with turbines are briefly discussed. The rotating field type of turbo-alternator is the one used almost exclusively at the present time; experience has shown this type to be less troublesome in practice than the rotating armature type; in connection with the latter (which is used in high-speed machines of small output and low voltage) difficulties have been experienced on account of the rapid wear and heating of the collector rings, and short-circuits caused by particles detached from the brushes. The Oerlikon Co. is constructing two 1,100-kw., 1,880-r.p.m. turbo-alternators of the *asynchronous* type with squirrel-cage rotors, the necessary exciting current being supplied to the armature by an ordinary synchronous machine. Such asynchronous generators are easily paralleled without any synchronising gear, and have no rubbing contacts, but they are expensive and less efficient (owing to large wattless exciting current) than machines of the synchronous type. The Société alsacienne de constructions mécaniques, Belfort, has also constructed a 500-kw. 3,000-r.p.m. asynchronous generator. Satisfactory continuous-current turbo-generators can only be constructed by having recourse to either commutating poles or compensating windings, preferably the latter, as these prevent field distortion and consequent flashing-over. The voltage per segment should be below 20, and the peripheral speed of the commutator should not exceed 25 to 30 m./sec. A. H.

990. *Parsons Turbine-blower.* **J. Fürstenau.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1125–1132, July 20, 1907.)—This paper gives a descrip-

tion of a Parsons turbine-blower used for furnace work, and also describes researches carried out with it to test its efficiency. Numerous diagrams are given, and the results obtained with the turbine-blower are compared with those for two piston-type blowers in the following table:—

	Turbine-blower.	Piston-type Blowers.	
		Trzynietz.	Hernadthal.
Air per min., cub. m.	578·65	540	557·6
Steam consumption per min., kg.	89·5	97·8	92
Pressure, atmos. abs.	1·454	1·466	1·45
Steam consumption per min. per 100 cub. m. of air, kg............	15·45	18·1	16·45

This shows the Parsons turbine-blower to be considerably more economical than either of the two piston-blowers. A. W.

991. *"Field-Morris" System of the Aeration of Steam.* F. A. Lart. (Eng. Rev. 17. pp. 69–76, Aug., 1907.)—The author describes two methods under this system of mixing a proportion of atmospheric air with the steam to be used in the cylinders of steam engines. In one method the air was forced by a Roots blower first into the jacket of the steam cylinder, from which—after heating and expansion—it passed into the cylinder through automatic air-inlet valves which opened directly the steam commenced to exhaust and closed when compression began at the end of the stroke. In the other method the air was compressed to boiler pressure by a compressor cylinder and then admitted to a superheater through which steam from the boiler was also passed, the highly heated mixture of air and steam then passing into the engine cylinder. Diagrammatic sketches illustrate both methods, the latter being considered the improved development of the first. It is maintained that in consequence of the peculiar property of heated air used in engines—that of returning the power expended in compressing it—this system realises great economies in steam, fuel, and wear. Trials are being carried out in locomotives and on stationary engines. Some figures are given showing a decided economy in the case of one non-condensing single-cylinder engine of 104·6 b.h.p., the steam consumption per i.h.p.-hour having been reduced from 31 lbs. to 18·6 lbs. F. J. R.

992. *Fuel Losses in Steam Power Plants.* G. H. Barrus. (Cassier, 32. pp. 321–332, Aug., 1907.)—Refers to a former article in Cassier which explained the methods employed in locating and measuring losses in steam plants in commercial operation, and in this article the author gives particulars of tests of about 15 different plants arranged in tables for comparison. The losses are stated to be due to methods of firing and handling the boilers (*i.e.*, using thick fires and running several boilers with slow fires at night instead of one or two efficiently), high flue-temperature, insufficient baffling of hot gases, not utilising waste heat, and uneconomical selection of fuel. In testing the losses from the entire plant, a factory employing different designs of steam engines and using steam for a variety of other operations is selected, different parts of the plant being tested separately, and a table gives a summary of the

total distribution of the coal apportioned to the several items of use. Out of a total consumption of 37,065 lbs. coal, it appears from the summary that 12,120 lbs., or about one-third, may be considered as thrown away, provided the plant were arranged to utilise all the steam to best advantage. That loss amounts to 5·4 tons of coal per day, representing an annual loss of $7,500. On the basis that improvements are warranted the economy from which will pay for them in four years, this loss would justify the expenditure of $30,000.

F. J. R.

993. *Diagram of Steam Properties.* **H. F. Schmidt** and **W. C. Way.** (Power, 27. pp. 524–526, Aug., 1907.)—The construction of the entropy diagram is explained by means of two figures, in order to show the origin and meaning of the various lines on a large chart which consists of a large number of similar diagrams superposed, so that the relation between absolute pressure, total heat, specific volume, and entropy may be found for a great variety of conditions. The definition of entropy which is given is that it means "transformation," referring to the heat per degree which is transferred to another body or transformed to another form, and it is written: Entropy $= \phi =$ (Heat transferred or transformed)/(Absolute temperature at which transfer or transformation occurs). [The lines of constant pressure in the superheated portion of the chart were calculated by a formula employing the value 0·48 for the specific heat of superheated steam, but recent research shows that this assumption is not correct.] F. J. R.

994. *Fuel Tests under Steam Boilers.* **L. P. Breckenridge.** (West. Soc. Engin., Journ. 12. pp. 285–324; Discussion, pp. 324–348, June, 1907.)—This paper gives a review of the work done by the author and assistants in the Boiler Division of the Fuel Testing Plant of the U.S. Geological Survey. After defining the limits of "efficiencies" used in the paper, a table is given showing the average results from about 150 specimens of American coals with the experimental boilers which were of the Heine form with hand-fired furnaces—the dimensions of boilers and settings being stated. The evaporative results with the coal as fired ranged between 4·81 and 9·54 lbs. per lb. coal, and the over-all efficiency of steam-generating apparatus ranged between 40·91 and 65·89 per cent. In a series of 22 charts the various results are arranged and compared to give curves showing the relations of volatile matter, ash, carbon to hydrogen ratio, average diam. of pieces of coal, furnace temperature, proportion of CO, proportion of CO_2, combustion chamber and flue gas temperatures, heat absorption, &c., to one another and to boiler efficiency. Charts of variations of temperature in furnace with firing and of theoretical curves of heat absorption as affected by air supply are also given, and illustrations of water-jacketed gas sampler, of apparatus for measuring rate of circulation of water in the boilers, and of experimental apparatus for measuring the rate of heat-transmission through boiler tubes. Particular attention is devoted to Perry's statement of the effect of velocity of the hot gases on the rate of heat transmission, and experiments with the experimental apparatus given in a table and chart of curves so far confirm his formula. In the *discussion*, **W. T. Ray** referred to and quoted a paragraph on the commercial aspect of the 400 boiler tests which was omitted from the paper, and held that J. Perry's view, if substantiated, put the boiler on a sound mathematical basis, similar to that of the dynamo. **H. Kreisinger** and **Perry Barker** also gave additional information regarding the tests. **R. S. Moss, A. J. Saxe,** and **F. Chauvet** asked questions dealing with the percentage

of CO_2, volatile matter and ash, and the stratification of gases interfering with sampling. **C. H. McClure** gave charts showing probable loss of heat due to unconsumed hydrocarbons which will be produced under the same conditions as CO. **A. Bement** criticised the work of the Boiler Division adversely and maintained that they should have aimed at the highest efficiencies instead of those shown. W. L. Abbott's paper [see Abstract No. 1884 (1906)] was one which had carried out preliminary investigations of great value from the results of which the Government ought to have started. The Boiler Division had omitted some obvious elements which limited the value of their results. **W. Kent** objected to the definitions of efficiency, and maintained that with proper arrangements for feeding coal and for combustion higher efficiencies can be obtained. As regards Perry's mathematical formula, he did not accept it, as there are not sufficient data available for a proper investigation of the subject. He wanted investigation also of the temperature and rate at which different coals give off their volatile matter. **Ray** and **Breckenridge** replied shortly to several of the points raised. F. J. R.

995. *Combustion Processes in Locomotive Fire-box.* **F. J. Brislee.** (Soc. Chem. Ind., Journ. 26. pp. 804–810; Discussion, pp. 810–811, July 31, 1907. Paper read before the Liverpool Section.)—Boudouard's investigations of chemical equilibrium are applied to the reactions taking place in a locomotive boiler fire-box under the conditions found there, and the application of le Chatelier's equation, with Kirchoff's expression of the law of change in the heat of reaction with temperature, to the calculation of the ideal composition of the gas resulting from combustion of carbon is shown. The ratio C_{CO}/C_{CO_2} gives the ratio of weight of partially burnt carbon to that completely burnt, and the ratio $CO/(CO + CO_2)$ is a measure of the carbon partially burnt compared to the total amount consumed. For efficient combustion these two ratios should be as small as possible, the maximum being reached when they are both zero. When combustion takes place in air (21 per cent. oxygen and 79 per cent. nitrogen) the proportion of CO can vary between 0 and 34·71 per cent., while the CO_2 can vary between 0 and 21 per cent. When coal is used the percentage is usually between 9 and 14. The effects of uniform size of pieces of fuel and of the velocity of the current of air or gases through the fire are considered, and 9 tables are given of analyses of the gases drawn from the smoke-box under varying conditions of speed of engine and vacuum in the smoke-box. A steady current of air in sufficient amount to produce the most suitable velocity of combustion gives the best results. F. J. R.

996. *Stresses in Boilers due to Temperature Differences.* **C. Sulzer.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1165–1168, July 27, 1907.)—Gives full data with results of tests of the metal of a boiler which developed cracks near rivet-holes during use. Near the cracks the tests in the direction of rolling gave the elastic limit as 18·0 tons per sq. in., and the tensile strength 21·1 tons per sq. in.; across the direction of rolling the figures were 15·2 and 20·7 respectively. It is thought that a higher elastic limit, and also a low elastic modulus are desirable. It is considered that the double row of circumferential rivets hold two short cylinders of steel plate together at their ends, whilst these have considerable temperature-differences produced between them, and hence stresses are set up due to differential expansion and contraction. The edge of the plate which is in contact with the hot gases, having to undergo greater variations of temperature, should be caulked more tightly than the edge which is immersed in water. F. R.

997. *Belt- and Rope-driving.* **Kammerer.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1085–1094, July 13, 1907. Extract from Mitteil. über Forschungsarbeiten.)—This paper give a description of researches on power transmission by belts and by ropes. The object of the research was to determine the effect on the efficiency, pulley friction, &c., of varying velocities, pulley materials, and pulley diameters. The research apparatus consisted of two pulleys, one driven by an electromotor and the other coupled to a dynamo. By measuring the electrical power of both machines and allowing for the calculable power loss for each, the efficiency of the drive could be determined. The driving pulleys used were rigidly built of iron. The diameters used were 2·5 m., 1·25 m., and 0·6 m. for the belt pulleys, the respective widths being 40, 60, and 100 cm.; the rope pulleys were 2·5 m. with 4 grooves, 1·5 m. with 6 grooves, and 1·04 m. with 9 grooves. The motors were of 200 h.p., and ran at from 200 to 600 r.p.m. The results arrived at for belts were as follows: (1) The slack-tension (k_v) can be made smaller than usual, because the frictional coefficient has been raised to about double the usual value; so that for a given total tension, the tension (k_n) for the drive can be raised. (2) The total tension $k_v + \frac{1}{2}k_n$ does not give rise to the stretch of the belt calculated from the slack- and drive-tensions, but the stretch is the further below this value the greater the velocity—for the increase of length of a loaded belt apparently does not follow the rapid increase in tension. (3) The efficiency η rises at first quickly with increased drive-tension, then is almost stationary for a time, after which the efficiency falls with further increase of tension. The highest value for η with belts 37·5 cm. wide was 0·94 to 0·98, the tension for this being about 3 to 5 kg. per cm. width. (4) The frictional coefficient μ has a limiting value of 0·6 to 0·8 when slipping begins. The limiting value is the higher the greater the diam. of the pulley and the belt velocity. For wooden pulleys it is greater than for iron. (5) The velocity v of the belt affects both the total tension and the coefficient of friction. For velocities of more than 20 m. per sec. the observed values of the tension are lower than the calculated values, and the lower the greater the velocity. (6) The material of the pulley makes a great difference to the value of μ; the effect of different materials is much greater than that for different diameters. For rope-driven pulleys the following conclusions were drawn: (1) The slack-tension K_v can be made much smaller than the value usually taken. The drive-tension can be raised to a maximum of about 0·8 K_t instead of 0·5 K_t, where K_t is the total tension. (2) The total tension $K_v + \frac{1}{2}K_n$, just as with belts, does not give the calculated stretch. The stretch is more and more below this value the greater the rope velocity. (3) The efficiency η in all cases rises very quickly with increased drive-tension; it rises to a maximum for a particular value of the tension and then falls away. With 4 ropes in parallel the maximum efficiency is not so great as with 1 rope; for 1 rope η has a maximum of 0·94 to 0·96 when $K_n = 80$ to 120 kg.-m. for a rope 3 cm. diam.; for 4 ropes $\eta = 0·89$ to 0·94, when $K_n = 35$ to 45. (4) The frictional coefficient μ has a value up to 0·6. (5) The effect of pulley-diam., rope velocity, &c., is similar to that for belts. (6) The efficiency for a round belt is a little higher than that for one whose section is a trapezium, as this requires a slightly higher slack-tension to prevent vibration. A. W.

998. *Utilisation of Waste Heat from Copper Smelting Furnaces.* (Eng. Record, 56. pp. 11–12, July 6, 1907.)—A description of the plant of the Colusa Parott Mining and Smelting Co. at Butte, Montana. The installation follows the general lines of the practice in steel mills, but special means have

to be taken for dealing with the dust and friable matters carried over from the smelting furnaces. The three smelting furnaces are of the reverberatory type, and are fired with coal. The waste gases formerly passed to the chimney-stacks with temperatures ranging from 1,500° to 2,000° C. This temperature is now reduced to 500° C. by means of the new waste-heat boiler installation, and one tall single stack has replaced the three independent ones to each smelting furnace. The waste gases from the boilers are passed through a dust-settling chamber 50 ft. wide by 19 ft. high by several hundred ft. in length before passing away up the chimney-stack. The boiler used with each smelting furnace is a 515-h.p. unit of the Worthington type. It is built with a central horizontal steam drum, with inclined banks of tubes, the steam drum being 42 in. diam. by 20 ft. long. There are 61 sections of water tubes, each with 8 full-length tubes and one shorter tube connecting with the lower side of the drum, making a total of 549 tubes. The tubes are 10 ft. in length by 8 in. diam., and the total heating surface presented to the hot gases by each boiler is 4,635 sq. ft. Apart from its size, the boiler presents no unusual features except in the casing. This is of special design to permit of cleaning while in service, the entire outer casing being formed of hinged doors, of which there are two on each end and six on each side. The spaces between the tubes are kept free from accumulations of dust by slotted openings in the lower doors at both front and back, through which cleaning bars may be inserted. The slots are 2 in. by 10 in. in size, and are cut through the doors in line with the openings between the headers of the boiler. These slots are closed when not in use by small flap doors hinged and held by buttons on the main doors. The installation is stated to be successful.

J. B. C. K.

999. *Refuse Destructors.* G. **Dettmar.** (Elektrotechn. Zeitschr. 28. pp. 641–645, June 27; 670–672, July 4; 691–695, July 11, and pp. 712–716, July 18, 1907.)—The author in this series of articles discusses (*a*) the different methods of disposing of towns' refuse; (*b*) the composition and thermal value of the same; (*c*) typical English destructor plant erected in Germany; (*d*) typical German destructor plants erected in Germany; (*e*) the actual costs of destructor-plant working; (*f*) the use of the surplus heat for electricity generation; (*g*) general considerations. Summarising the facts and opinions based upon them as set forth under these various headings, he states that the method of disposing of towns' refuse in destructor plants is of great importance, both from the hygienic and business points of view, and that at the present time this method is the best solution of the difficult problems connected with the disposal of such refuse. The use of the surplus heat for electricity generation is also of considerable practical importance, since this electricity can be applied to various purposes, while during times of light load the surplus heat may be utilised directly in baths or washhouses adjoining the destructor plant. J. B. C. K.

GAS AND OIL ENGINES.

1000. *Two-stroke or Four-stroke System in Large Gas Engines.* v. **Handorff.** (Gasmotorentechnik, 7. pp. 3–5, April, and pp. 21–24, May, 1907.)—The engines taken for discussion by the author are the double-acting Körting (2-stroke) engine, and the 4-stroke-cycle, double-acting tandem engine. The first point in design which is against the 4-stroke engine is held to be the need for making all parts strong enough to bear high maximum explosion pressures, which are

only intermittent and are much above the mean pressures. Against this, the 2-stroke engine has, by reason of the charging process, to necessarily run at a considerably lower speed; the cylinder must also be of the long-stroke (and hence narrow bore) type, for the scavenging effect not to interfere with the mixture charge. Thus in the case of a 1,000-h.p. Körting engine the stroke is about 1,400 mm., and the speed 88 r.p.m. A 4-stroke engine of the same output need only have a stroke of 1,000 mm., and the speed can be about 107 r.p.m. Hence, for the purpose of driving electric generators, the generator will cost less when it is to be coupled to a 4-cycle engine, as the construction is less expensive owing to the higher speed. For blowing engines, on the other hand, both types stand on an equal footing, or, if anything, the lower speed is to be preferred. The design in the case of the double-acting two-stroke engine is considered superior, so far as reliability in service is concerned, on account of its having only 2 valves and 2 pumps, against the 6 valves (and, generally, 4 additional regulating valves) of the 4-stroke-cycle engine. L. H. W.

1001. *Electrical Method of Depolarising Primary Batteries for Ignition Purposes.* **F. W. Springer.** (Univ. of Minnesota, Engin. Soc., Year Book, pp. 29–85, 1907.)—A brief account of an arrangement in which the spark ignition for petrol engines, &c., is provided by a dynamo in parallel with a primary battery. Both dynamo and battery co-operate to produce the coil-spark, and the dynamo current passes through the battery in the reverse direction during the inactive intervals. The dynamo, it is claimed, can be reduced in size, and the life of the battery is prolonged by reason of the intermittent depolarising current. L. H. W.

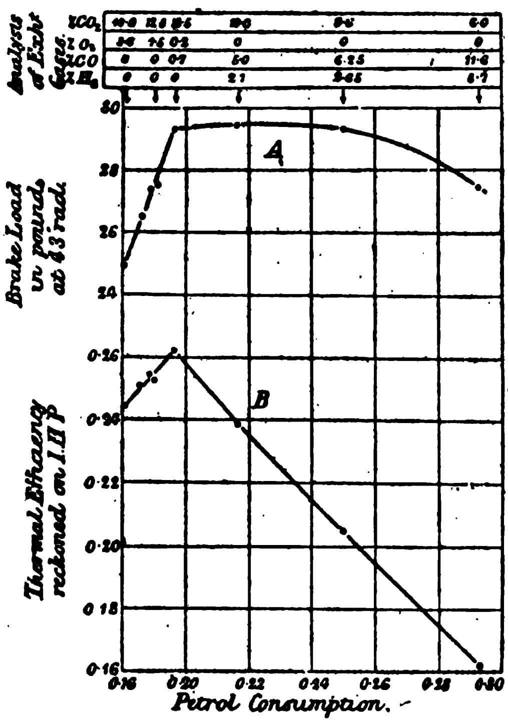
1002. *Gases exhausted from a Petrol Motor.* **B. Hopkinson and L. G. E. Morse.** (Engineering, 84. pp. 219–221, Aug. 9, 1907. Paper read before the British Assoc. at Leicester.)—Gives results of a series of tests with a 4-cylinder, 16 to 20-h.p. Daimler engine at the Engineering Laboratory of Cambridge University. Particulars of engine: Total volume of one cylinder with piston at out-centre, 0·04 cub. ft.; volume of compression space, 0·0104 cub. ft.; compression ratio, 3·85; diam. of cylinder, 3·56 in.; length of stroke, 5·11 in. The engine was run at a nearly constant speed of 700 to 750 r.p.m. Petrol used was Pratt's spirit of density 0·715 to 0·720; calorific value, 18,900 B.Th.U. per lb. (lower value).

RESULTS OF TESTS ON TWO CONSECUTIVE DAYS.

Petrol consumption, lb. per 1,000 revs.		0·181	0·191	0·197	0·217	0·250	0·298
Brake load at 48-in. radius, lbs.		25	27·5	29·8	29·4	29·8	27
Thermal efficiency		0·244	0·252	0·261	0·238	0·204	0·162
Percentages of the volume of dry exhaust gas.	CO_2 measured	10·9	12·8	13·5	10·6	9·6	6
	O_2 measured	8·6	1·5	0·2	—	—	—
	CO measured	—	—	0·7	5	6·25	11·6
	H_2 measured	—	—	—	2·1	2·65	8·7
N_2 by difference		84	84	84	81	80	78
Total O_2 calculated from N_2		22·4	22·4	22·4	21·5	21·3	19·4
H_2O calculated		15·8	16·2	16·8	16·8	17·2	15·2

The composition of the petrol, determined by combustion and weighing the CO_2 and H_2O produced, was: H., 14·86 per cent.; C., 84·66 per cent., from

which the volume of steam formed should be 1·05 times the combined volume of CO_2 and CO when the petrol is all burned. The ratio of these two volumes is always considerably greater than this. The quantity of available oxygen is probably about sufficient to burn 0·19 lb. petrol under atmospheric conditions; the quantity actually taken in by the engine was practically constant. Curve A, on annexed diagram, shows the relation between brake-load and petrol consumption, the quantity of CO and O found in the exhaust



being marked at various points on the curve. Curve B shows the thermal efficiency based on the actual petrol consumption and the indicated power. Incompleteness of combustion shown in B appears to be caused by dilution of the explosive mixture with exhaust gas of the previous explosion. Figures show that this dilution amounted to nearly half the volume of mixture entering the cylinder. Indicator diagrams taken with different quantities of petrol are given and show the characteristics of the mixtures and also the effect of advancing the spark. F. J. R.

1003. *Test of a Gas-engine Plant at Boston.* (Electrical World, 50. p. 175, July 27, 1907.)—This plant consisted of a 55-h.p., Bruce-Abbott-Merriam vertical twin-cylinder gas engine working on the four-stroke cycle, with throttling governor and quality governing, coupled direct to a 30-kw. Bullock generator of 230–240-volt direct-current type, with auxiliaries. The gas used was town's gas of 590 B.Th.U. per cub. ft. at a pressure of 2 in. of water. Runs of an hour at constant load and all-day runs also were made in which the voltage was maintained constant at 220 volts. The wattmeter was also

left in circuit for 2 weeks, during which readings of it and of the gas meter were taken, the total kw.-hours being 8,146, and the total gas used 92,900 cub. ft. The loss in circulating pump (driven by motor) was 31·9 kw.-hours, leaving 8,114 kw.-hours net energy. Gas consumption was 29·8 cub. ft. per kw.-hour; and B.Th.U. per kw.-hour output was 17,580, and per h.p.-hour of engine assuming an average efficiency of 89·5 per cent. for the generator, was 11,780 B.Th.U. Average thermal efficiency of the engine was 21·7 per cent., and of the set 19·4 per cent. The total net cost of energy per kw.-hour was 2·312 cents, and the fixed charges 0·555 cents. Total energy cost per kw.-hour was therefore 2·87 cents. F. J. R.

1004. *Gas Turbine Theory.* **F. Langen.** (Zeitschr. ges. Turbinenwesen, 4. pp. 156–158, April 10, and pp. 319–322, July 30, 1907.)—In this paper the author discusses the effect on the efficiency and power of several types of turbine, of excess of air, and also of cylinder temperature. The types treated are the following: Rateau turbine, 500-h.p. Armengaud-Lemâle petroleum turbine, and 200-h.p. de Laval turbine. The petroleum turbine appears to be, from the researches discussed, considerably less efficient than the other types. It is improved by the use of compressed oxygen, and the power is increased about three times by heating the compressed air to 1,800° C. before the expansion instead of using cold air. The author suggests that by using compressed oxygen the petroleum turbine may be utilised for submarines. In the second paper the explosion turbine is similarly treated. From a discussion of Meyer's researches the author concludes that in all cases where from any cause a piston motor is unsuitable, the use of a steam turbine with superheating gives a more economical utilisation of furnace gas than the employment of a gas turbine. When a gas turbine must be used the explosion turbine has many advantages. A. W.

REFERENCES.

1005. *Efficiencies of Impulse Steam Turbines.* **F. Langen.** (Zeitschr. ges. Turbinenwesen, 4. pp. 261–264, June 20, 1907.)—The article deals first with the friction losses in impulse steam turbines with various numbers of wheels, and then with the leakage losses due to the clearances. Formulæ are deduced for these quantities. The writer concludes that the "marine steam turbine of the future" is the impulse type, and that, for land turbines of very large capacity, this is also the most hopeful type. H. M. H.

1006. *Analytical Data of American Coals.* **A. Bement.** (Soc. Chem. Ind., Journ. 26. pp. 670–672, June 29, 1907.)—A tabular statement of the composition of 87 American coals, the analytical results being calculated upon "*pure coal*" and upon "*combustible*" under the following headings: *Pure coal.*—Available hydrogen, carbon, sulphur, water of combination, nitrogen, and B.Th. Units. *Combustible.*—Available hydrogen, carbon, sulphur, and B.Th. Units. The moisture and ash tests for these coals, owing to the defective methods of sampling, were not sufficiently accurate to be included. "Water of combination" includes the hydrogen required for combination with the oxygen present in the coal, and "available hydrogen" represents that in excess of this amount, this alone being that available for heat production. The heat values were determined by the Mahler bomb calorimeter, with the exception of the Michigan samples. J. B. C. K.

1007. *Petrol and other Fuels for Engines of Automobiles.* (Automobile Club Journ. 14. pp. 108–126, July 25, 1907. Report of the Fuels Committee.)—Deals with the supply of petrol, alternative fuels to petrol, and comparative advantages and disadvantages of alcohol and petrol. [See also Abstract No. 867 (1907).]

INDUSTRIAL ELECTRO-CHEMISTRY, GENERAL ELECTRICAL ENGINEERING, AND PROPERTIES AND TREATMENT OF MATERIALS.

1008. *Test of an Ozoniser.* **A. W. Ewell.** (Electrochem. Ind., N.Y. 5. pp. 264–265, July, 1907.)—Gives tests of an ozoniser, constructed with flat, narrow, bare electrodes with glass midway between, of 200 watts capacity at 18,200 volts. Between the compression pump and the ozoniser the air was passed through a gas meter, through a potassium permanganate solution for the removal of organic matter, and then through $CaCl_2$ drying columns. The following figures are taken from a table given :—

Current through Ozoniser, Milliamps.	Gas Velocity, Litres per Min.	Mgm. of Ozone per Min.	Concentration, Gm. of Ozone per m.^{3}.	Yield, Gm. of Ozone per Kw.-hour.
10·5	6	22	3·6	19
8·6	3	17	5·6	16
8·6	6	24	4·0	22
5·7	24	37	1·6	53
6·8	24	44	1·8	55
8·3	24	53	2·2	56

The decrease in yield at high concentrations is attributed to the de-ozonising effect of the current. The author urges that claims as to the comparative efficiencies of ozonisers can only be of value when the yield is given in gm. per kw.-hour. The above figures refer to the ozoniser only, transformer losses being deducted for the purpose of calculation. W. P. D.

1009. *Manufacture and Use of Carbon Tetrachloride.* **J. R. Crocker.** (Electrochem. Ind., N.Y. 5. pp. 259–261, July, 1907.)—Commences with a description of the physical properties of carbon tetrachloride, and proceeds to discuss removal of traces of the same from oil-cake. The author also discusses the effect of this solvent upon machinery with which it may come in contact. In the absence of moisture, steel, cast iron, and wrought iron are only slightly affected. The presence of moisture, particularly when the solution is being rapidly circulated, occasions decomposition with the formation of oxide of iron and ferric chloride. The carbon tetrachloride should be as nearly anhydrous as possible. Lead, Pb-Sb alloys, and tin resist corrosion. Copper and its various alloys are satisfactory at low temperatures. Zinc and Al are fairly good. At high temperatures Ni is more subject to corrosion than any other metal. Lead-lined and tin apparatus have therefore been suggested, but are impracticable in the construction of the extracting plant. The author then proceeds to discuss various methods of manufacture, and describes in detail the carbon bisulphide process. The chlorine gas, preferably obtained by electrolytic means, is first dried by passing over sulphur and sulphuric acid, and then passed over carbon bisulphide, forming tetrachloride gas and sulphur chloride. This gas is cooled and treated with lime or caustic soda to precipitate the sulphur chloride and other impurities. After

drawing off the precipitate and again agitating, the gases given off are again condensed, and the finished product—clear anhydrous carbon tetrachloride —obtained. Another recently patented method is characterised as quite feasible. The reaction depends upon the introduction of $CaCl_2$ and carbon into an electric furnace, the gas evolved being introduced into a chamber for the condensation of the volatile compounds. The gases then pass to an ordinary condenser, leaving the same as carbon tetrachloride. If successful, a process of this character would be far superior to the carbon bisulphide process as dispensing with an inflammable agent and complicated and costly apparatus. W. P. D.

1010. *Electrolytic Reduction of Low-grade Copper Ores.* **D. A. Willey.** (Elect. Rev., N.Y. 51. pp. 52–54, July 18, 1907.)—A description of the smelting and refining plant at Tacoma, Washington, recently completed for the Tacoma Smelting and Refining Co. This plant treats copper and lead ores containing down to 1 per cent. of pure metal, and earns a profit on the results. The raw ores are drawn from the mines of British Columbia, Alaska, California, Oregon, Mexico, South America, and Europe, and over thirty varieties have been roasted in the Tacoma smelter. The skill used in mixing the ores is one reason why it has been made profitable to work such low grades. The concentrate furnace in the copper plant is of the Allis-Chalmers type, and has a maximum capacity of 850 tons per 24 hours. The metal obtained from this furnace is run into ladles, and taken directly to the converting department, where it is run through a cupola, and then blown in a tilting converter. The process used is similar to that used for Bessemer steel, and the product remaining is crude copper with a high percentage of impurities. This copper is next cast into anodes, the furnace used for this work being of the rotary type and heated by oil fuel. The anodes weigh each 125 lbs., and from 20 to 24 days are required to work them down in the electrolytic vats. The kathodes and anodes are set in the vats with a clearance of only 1 in. Each vat takes a charge of 18 anodes and 19 kathodes, a travelling crane of 20 tons capacity being used to charge and discharge the vats. The electrolyte is a solution of copper sulphate containing 16 per cent. of this salt and about 5 per cent. free sulphuric acid. The vat slimes containing the silver and gold are treated with a 25 per cent. solution of sulphuric acid, and are then dried and worked up for the noble metals in the lead refinery. A current density of from 10 to 15 amps. per sq. ft. is employed in the copper depositing vats, but this is varied according to the amount of silver and arsenic present in the anode copper. Less than ½ volt per vat suffices to distribute this current through the refinery. The current is brought to this department by 10 cables, and is transformed from 40,000 volts, the pressure at which it is transmitted from the generating station 40 miles distant in the foot-hills of Mount Ranier, to 100 volts—the pressure at which it is used in the works. A noteworthy feature of the works is the slag-casting machine attached to the concentrate furnace. This machine is of the circular type, is provided with 144 tilting moulds, and has a total capacity of 20 tons. The Tacoma Works utilises about 2,000 h.p. in the various departments, and has a daily output of from 80 to 48 tons of copper. J. B. C. K.

1011. *Ferro-Molybdenum.* (U.S. Pat. 852,920. Electrochem. Ind., N.Y. 5. p. 241, June, 1907.)—H. W. C. Annable claims the following process for producing ferro-molybdenum from molybdenite. The ground ore, consisting largely of molybdenum sulphide, is heated with Na_2CO_3 or NaOH, or both, in

a reverberatory furnace, and partially oxidised to sodium sulphate, molybdate and hydroxide. These bodies are extracted with hot water, and molybdate of iron free from sulphur is precipitated by means of iron chloride or sulphate, dried, and reduced to ferro-molybdenum either by (*a*) a current of coal-, producer-, or water-gas at a low red heat, or (*b*) heating at 1,300° to 1,400° C., together with sufficient oxide of iron to produce a ferro-molybdenum fusible at this temperature, and with sufficient carbonaceous matter to reduce the oxides. In method (*b*) it is arranged that the reduced ferro-molybdenum drops into oxide of iron, and in percolating through becomes practically carbon-free. F. R.

1012. *Magnetic Manganese Steel.* (U.S. Pat. 856,250. Electrochem. Ind., N.Y. 5. p. 283, July, 1907.)—R. A. Hadfield claims steel with less than 1 per cent. C, and from 10 to 40 per cent. Mn. The C is kept lower than in high Mn steels as heretofore made, by using an electric furnace ferro-manganese. The resulting steel is less liable to fracture in cooling and thermal toughening treatments, and is more strongly magnetic than the corresponding higher carbon alloy. F. R.

1013. *Vulcanisation Tests with Plantation Rubbers.* **C. Beadle** and **H. P. Stevens.** (Chem. News, 96. pp. 37–39, July 26, 1907.)—Somewhat better tensile test results were obtained with vulcanised plantation rubbers than with a similarly vulcanised hard-core Para of good average quality. Whilst the tests are not sufficient to show that this result will be general, it is concluded that the plantation rubbers will prove to be at least as good as the Amazonian. It is found that, generally, within limits, additions of mineral matter to rubber result in increase of tensile strength and diminished elongation. F. R.

1014. *Tests on Rubber Cables.* **H. W. Fisher.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 843–866, June, 1907.)—The author attempts to ascertain whether it is possible to determine the quality of a rubber cable by purely electrical tests. A number of cables of different makes were taken and tested. The thickness and nature of the insulation on each were first determined, together with the breakdown voltage. The rubber compound was then very carefully tested chemically, and a complete analysis of each sample was made. After this, each cable was submitted to a series of electrical tests on energy-losses in the dielectric, variation of insulation resistance with prolonged immersion in water, variation of inductive capacity under similar conditions, &c., &c. The results did not appear to be altogether conclusive, and the electrical tests did not always pick out with certainty those cables which had the highest percentage of Para rubber. W. H. S.

1015. *Induction Type Ammeters, Voltmeters, and Wattmeters.* **P. MacGahan** and **H. W. Young.** (Electrical World, 50. pp. 138–141, July 20, 1907.)—The ammeters, voltmeters, and wattmeters described in this article all operate on the "induction principle." A rotating magnetic field is produced by the alternating current. The eddy currents generated in a pivoted metallic shell placed in this field produce a torque which can be measured. In the ammeter the moving element consists of a light aluminium cylindrical shell, mounted on a shaft provided with highly polished steel pivots, and located in an annular gap. The shaft carrying the indicating pointer is sup-

ported in jewelled bearings and is controlled by a spring. As the resistance of the moving cylinder varies directly with the absolute temperature, the torque will vary inversely as this temperature. To compensate for the effects produced by changes of temperature in ordinary "induction type" ammeters a device consisting of coils of copper wire wound non-inductively and connected in parallel with the magnetising coils is employed. As the frequency increases the compensating coils take more of the current, and as the temperature increases they take less, thus compensating for changes in both temperature and frequency. By utilising the "series transformer principle," however, a rotating field is produced, which in conjunction with a proper rotor produces a torque that is practically independent of the frequency and the temperature within wide limits. In the voltmeters the same construction is employed, but the primary winding has a large number of turns of fine wire in series with an internal resistance of zero temperature-coefficient. In order that the voltmeter may read correctly with frequencies of 25 and 60, the series resistance is tapped at two points and connected with two terminals. By using the proper tap the meter reads correctly at either frequency. The wattmeter is similar in appearance to the ammeter, but the transformer principle is not employed, the rotating field being obtained as in an induction motor. With the exception of the metal used for the construction of the cylindrical disc, the rotor is identical with that of the ammeter. The metal used is a special alloy having a low temperature-coefficient. The polyphase meter consists of two separate single-phase elements mounted in a single case, and having a common shaft carrying the two rotors, which revolve in separate fields. The meter reads unbalanced loads on two- or three-phase circuits correctly. The advantages of "induction type" meters are: Absence of moving wires or iron, light and simple moving elements, long open scales; they are unaffected by stray fields and inherently dead-beat. A. R.

1016. *Instrument Transformers.* C. C. Garrard. (Elect. Engin. 40. pp. 115–118, July 26, and pp. 187–189, Aug. 9, 1907.)—To measure high p.d.'s low-tension voltmeters and transformers are now usually employed. As the high tension must be kept away from the switchboard it is necessary to insulate very carefully the primary from the secondary circuit. For all voltages greater than 2,000 a mica tube of ample thickness should be used to insulate the circuits from each other. This tube should be used even if the transformer be immersed in oil, but in this case it is necessary to impregnate the tube with a varnish which is unacted on by the oil. Oil ought always to be used when the voltage exceeds 5,000. Vacuum drying ought always to be used before the coils are varnished. Trouble is often caused by the polarity of the terminals of the voltage transformers not being definitely indicated. The author suggests that they should always be arranged so that the interposition of the transformer between the instrument and the line should be exactly equivalent to connecting the instrument with the line so far as the polarity of the terminals is concerned. The high-tension terminals should always be marked A and B, and the low-tension terminals *a* and *b*. This scheme of marking terminals can be applied to all current and potential transformers, whether single or polyphase. A potentiometer method is described of testing high-tension voltmeters. A special form of non-inductive resistance made by the Cambridge Scientific Instrument Co. is described. It consists of a series of china tubes, plain on the outside but fluted inside, and it is intended for use up to 15,000 volts. There are twenty tubes, each 18 in. long and 1·25 in. outside diam., mounted on a wooden frame. Each

tube is wound in four sections, the sections being wound non-inductively. The wire used is 45 S.W.G., the total resistance being 0·6 of a megohm. The author finds that the electrostatic capacity is equivalent to 0·0042 mfd. per section of 7,500 ohms. This capacity effect is negligible in practice when calibrating voltmeters. It is large enough, however, to prevent the use of such a resistance for the series coil of a high-tension wattmeter shunt, owing to the phase displacement producing a serious error at low-power factors. The Fleming form of ratio resistance is commended, and a simple form devised by the author is described. A theoretical discussion is given of the error introduced into divided resistance high-voltage measurement by the capacity of the voltmeter. When proper precautions are taken the method of divided resistance enables the highest voltages to be easily and accurately measured. The self-inductance, capacity, &c., of the resistances used must be carefully measured or calculated, and the errors introduced by them computed to see whether they affect appreciably the accuracy of the method.

A. R.

1017. *Special Tariff Meter.* **E. Wagmüller.** (Elektrotechn. Zeitschr. 28. pp. 781–782, Aug. 8, 1907. Paper read before the Verband Deutsch. Elektrotechniker, Hamburg.)—The meter described by the author is one which only registers when the current exceeds a certain limit. It is intended for use in cases where the consumer is charged a certain rental for a given current, irrespective of the number of hours during which the current is used. In order not to restrict the consumer in any way, he is supplied with the meter in question. This meter consists of a simple form of motor (whose field is formed by a permanent magnet), having its armature in a shunt circuit across the mains, and running at a constant speed. The motor drives, through suitable bevel wheels, a spindle carrying an aluminium disc, against whose surface is pressed a small counting roller (geared to the counting mechanism). This roller is arranged to be movable, and is attached to the core of a solenoid traversed by the main current, so that as the current increases the roller moves radially outwards along the disc, and its velocity increases. The roller is normally pressed against the centre of the disc, and is maintained in this position by a detent and an antagonistic spring, so that it is pulled outwards only when the current exceeds the normal value. The consumer, in addition to the fixed rental, is charged for the amount registered by the meter.

A. H.

1018. *Heating of Copper Conductors.* **A. E. Kennelly** and **E. R. Shepard.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 795–821, June, 1907.)—The temperature-rise of the conductor experimented upon was determined by the increase of resistance method. The conductor was connected in series with a German-silver standard resistance, and the coils of a differential galvanometer were connected across the conductor and standard resistance respectively. As the resistance of the conductor increased, additional resistance was introduced into the galvanometer coil across the standard resistance so as to maintain balance. The temperature-coefficient of copper was assumed to be 0·42 per cent. per 1° C. from 0° C. The conductors experimented on included rubber-covered wires, immersed in running water or placed in wooden moulding, and bare wires surrounded by sand, soil, or gravel. It was found that in all the above cases the temperature-rise θ could be represented by the formula $\theta/(1 + a\theta) = ki^2$, where k is a constant depend-

ing on the thermal conductance of the medium surrounding the wire, *a* the temperature-coefficient of the wire for the initial temperature, and *i* the current. Tables are given of the thermal resistivities of the various materials used by the authors for surrounding the bare wires. A. H.

1019. *Insulating Materials.* **W. S. Conant.** (Electrical World, 50. pp. 127–129, July 20, 1907.)—The author discusses the characteristics of the various insulating materials employed in the construction of electrical machinery. From tests carried out on a number of samples of a selected quality of mica, of thicknesses up to 5 mils, he finds the dielectric strength to vary from 1,980 to 4,300 volts per mil, the average being 2,500 volts. The averages of two assortments of poorer grade mottled samples from different localities were 2,200 and 2,400 volts per mil respectively. White mica in both large and small sheets averaged 8,100 volts per mil. Similar qualities of mica show little difference in dielectric strength, whether mined in the U.S.A., Canada, or India. Built-up mica, if cemented with a non-hygroscopic varnish, possesses considerable advantages over pressboard or other fibrous insulators for core, slot, or coil work; it can be made to within 0·01 in. of the desired thickness. The main disadvantage of pressboard is the possibility of the presence of pinholes or conducting particles too small for detection by the eye; thicknesses of over 0·08 in. should be avoided, and if a greater thickness is required it is better to use two thinner sheets. Vulcabeston in the form of a sheet $\frac{1}{32}$ in. thick will break down at about 2,600 volts. Thin paper (0·007 in.) will be punctured by 500 volts. All fibrous insulators exhibit large variations in their dielectric strength. In dealing with insulating varnishes the author condemns simple gum varnishes (copal, shellac) and bitumen and other mineral pitches, as when subject to vibration they crumble away. Linseed oil thoroughly boiled has been used with success in many varnishes; unfortunately such varnishes in course of time oxidise and crack, and the acids present in the oil attack both metal and organic materials. The author suggests that the best results would probably be obtained by the use of several varnishes, that next the coils being non-corrosive, and the outermost layer being weather- and acid-proof. A. H.

1020. *Proposed Lightning Arrester Test.* **N. J. Neall.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 957–962, June, 1907. West. Electn. 41. p. 4, July 6, 1907.)—The test proposed by the author consists in sending a spark discharge from an induction coil through the series of gaps forming the lightning arrester. The arrangement of connections is as follows: One terminal of the secondary of the testing induction coil is connected to earth through a condenser. The other terminal is connected, through a condenser and auxiliary set of spark-gaps, to the middle point of the lightning arrester gaps. The auxiliary set of gaps is introduced in order not to weaken the dielectric strength to earth of the arrester gaps. In applying the method to a three-phase transmission line the arrangement of connections described would be repeated for each transmission wire. In this way the secondary effects (short-circuits, sudden earths, and oscillations) of a discharge over the arrester gaps could be studied. The method has so far been only tried on a 2,800-volt laboratory circuit. A. H.

1021. *Speed Regulation of High Head Hydro-electric Plants. Simultaneous Oscillographic Measurements of Voltage, Current, and Speed.* **H. E. Warren.** (Technology Quarterly, 20. pp. 187–208, June, 1907.)—The author discusses

the various methods used for regulating the speed of water-wheels, and the methods available for testing the speed regulation. He considers ordinary tachometers unreliable unless they have been carefully calibrated. Frequency indicators are generally correct at the frequency for which they are intended, but cannot, as a rule, be depended upon at other frequencies. The author has successfully used the oscillograph for obtaining simultaneous measurements of voltage, current, and speed by the following method: A moving photographic film records the vibrations of three oscillograph mirrors. The first oscillograph is connected to an auxiliary generator, which is kept running light at a constant speed, and which supplies the time scale. The second oscillograph, which records the voltage and speed variations of the machine under test, is connected across the terminals of this machine; the spots of light due to these oscillographs are made to coincide when at rest. The motion of the photographic film is relatively slow, so that a very large number of waves are recorded in a short length of film. Owing to speed fluctuations interference takes place between the two sets of superposed waves recorded by the first two oscillographs, and the interference bands produced furnish an extremely accurate method of determining the speed fluctuations. At the same time the variations in the voltage are obtained from the varying amplitude of the p.d. wave. The third oscillograph traces an independent curve of current. A. H.

1022. *The Beck "Regler."* (Elect. Engin. 40. pp. 165–166, Aug. 2, 1907.)—This apparatus, which is made by the Beck Flame Lamp, Ltd., consists of special resistance wires arranged in glass tubes filled with a special gas chosen for its properties of conducting heat. No further technical details are given of its construction. It is used for preventing rushes of current when the voltage on a circuit suddenly rises. Thus when, by doubling the voltage, the current with an ordinary resistance would rise from 8·8 to 12·1 amps., the current only rose to 9·1 amps. when the resistance consisted of the Beck "Regler." It may be made for currents of any value between 8¼ and 400 amps. C. K. F.

REFERENCES.

1023. *Alternating-current No-voltage Release with Time-element.* (Elect. Engineering, 1. p. 846, May 16, 1907.)—Of the shaded-pole rotating disc type, designed by C. C. Garrard and manufactured by Ferranti, Ltd.

1024. *Theory of Fuses.* F. **Emde.** (Elektrotechnik u. Maschinenbau, 25. pp. 455–460, June 16, and pp. 478–481, June 23, 1907.)—This paper contains an analytical investigation of the temperature-rise and temperature distribution along a fuse-wire. The thermal capacity of the terminals between which the wire is clamped is assumed to be so great that their temperature-rise may be neglected. The general solution obtained is applied to the case of a tin fuse-wire. The paper concludes with some general remarks on problems in heat. A. H.

1025. *Lightning Arresters.* E. E. F. **Creighton.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 867–918, June, 1907.)—This paper deals with lightning arresters in a general manner. The author considers the terminology of the subject, the characteristics and methods of testing lightning arresters, and formulates recommendations for the protection of various types of plants. The aluminium arrester is strongly recommended as an additional protection, to be used in conjunction with the multi-gap arrester. A. H.

GENERATORS, MOTORS, AND TRANSFORMERS.

1026. *Regulation of Homopolar Dynamos.* (West. Electn. 41. p. 80, Aug. 3, 1907. Electrical World, 50. p. 374, Aug. 24, 1907.)—If the field winding of a homopolar (unipolar) dynamo be connected as a shunt across the terminals of the machine, the great increase in the contact drop between the end-rings and brushes which occurs with increase of load results in a considerable weakening of the field and in poor voltage regulation. In order to maintain the exciting current constant in spite of changes in the load, E. Thomson has patented the following arrangement. The field is connected, through brushes, to two end-rings belonging to the same conductor; this may be either a special conductor provided for the purpose, or it may be one of the armature conductors; in the latter case, the conductor must obviously have a larger area than the other conductors, in order to enable it to carry the larger current without undue heating. (U.S. Pat. 859,350.) A. H.

1027. *Improved Methods of Ventilation for Dynamos.* (Brit. Pats. 8,480 and 9,090 of 1906. Engineering, 84. p. 65, July 12, 1907. Abstracts.)—In the first method the inventor, H. Chitty, secures efficient ventilation by providing a space all round the field core, between the core and the coil, and ventilating ducts passing through the pole and communicating with exterior space. In the second method, armature and field are rotated in opposite directions; both cores are laminated, and are provided with ventilating ducts containing suitably arranged vanes which drive the air radially outwards. A. H.

1028. *Balancing of High-speed Rotors.* **M. Kroll.** (Elektrotechnik u. Maschinenbau, 25. pp. 583–586, July 28, 1907.)—After a general discussion of the problem of balancing high-speed machinery, the author describes the following method of securing balance. Two balancing discs, with suitable grooves for receiving balancing weights, are provided, one at each end of the rotor. The bolts holding down the caps of the bearings are slackened, so that each cap is free to move through a small distance in a vertical direction. Above each cap is arranged a device for measuring the upward thrust of the bearing. This device consists of a strong flat metal capsule, formed by two castings bolted together, and divided into two compartments by a membrane. The upper compartment is filled with an air-free liquid, and is connected to a manometer. The lower compartment is nearly filled by the expanded head of a pin which is attached to the membrane. This pin passes freely through a suitable guide-hole and rests on the cap of the bearing. Any upward displacement of the cap will compress the liquid in the upper compartment of the manometric capsule, and the amount of pressure so produced will be indicated by the pressure gauge. The rotor, which has previously been balanced statically, is provided with an additional pair of weights, a weight being placed in each balancing disc, the weights being equal and at the same distance from the shaft but on opposite sides of it. The rotor is run up to speed and the reading of the pressure gauge noted. The diametral plane containing the weights is then gradually shifted until the pressure gauge gives a minimum reading. By now altering the values of the weights without altering their positions, the pressure may be made to vanish, and the

dynamical balance may be regarded as sufficiently good for practical purposes. Still more perfect balance may, however, be obtained by continuing the alteration in the weights until the pressure gauge once more begins to read. If w_1 is the value of each weight which just causes the reading to vanish, and w_2 that which just causes it to reappear, then $\frac{1}{2}(w_1 + w_2)$ will give practically perfect balance. A. H.

1029. *Effects due to Toothed Core Armatures.* **R. Rüdenberg.** (Elektrotechnik u. Maschinenbau, 25. pp. 599–606, Aug. 4, and pp. 618–623, Aug. 11, 1907. Rev. Électrique, 8. p. 129, Sept. 15, 1907. Abstract.)—This paper contains an elaborate mathematical investigation of the various effects arising from the presence of teeth in the armature core. In calculating the e.m.f. of an armature, it is usual to neglect the periodic swaying of the magnetic flux in the air-gap, and to proceed on the assumption that the flux distribution is that corresponding to a smooth-core armature. The author shows that this procedure is not quite correct, as the swaying of the flux introduces additional higher harmonics into the e.m.f. wave. Under certain conditions, resonance takes place between the harmonics present in the e.m.f. wave and those due to the periodic swaying of the flux. In alternators, there are in general two such reinforced harmonics, which during a complete period of the fundamental wave perform a complete beat. If resonance of such harmonics occurs in continuous-current machines, they give rise to internal currents which, in exceptional cases, may reach values equal to a multiple of the full-load current, thereby occasioning large additional losses which are independent of the load. If the conditions for resonance are absent, the harmonics may appear in the external circuit in the form of alternating currents superposed on the main current. In the case of machines having distributed windings in both stator and rotor, the stator and rotor teeth should not be equal or stand in a simple ratio to each other, otherwise very strong resonance e.m.f.'s may make their appearance—a conclusion already arrived at long ago empirically. The teeth occasion additional eddy-current losses which may reach very high values, and which give rise to mechanical vibrations, causing the machine to "howl." By reason of their high frequency such additional losses will increase less slowly than in proportion to the square of the speed—a fact which should be taken into account in any methods employed for separating the losses. In order to avoid the danger of resonance the number of teeth per pole-pair should be even. A. H.

1030. *E.M.F. Induced in Alternator Shaft.* **F. Punga** and **W. Hess.** (Elektrotechnik u. Maschinenbau, 25. pp. 615–618, Aug. 11, 1907.)—In the case of certain high-speed alternators the bearings have been found to wear away very rapidly, and a p.d. of a few volts has been found to exist between the shaft and the bearings. At first sight it might be supposed that the film of oil surrounding the shaft would form a sufficient insulating barrier, but practically such has not been found to be the case, and where the trouble alluded to has been experienced it has become necessary to completely insulate the bearing pedestals from the bed-plate. The trouble arises from the presence of an e.m.f. induced in the alternator shaft. In order to account for this e.m.f., the author considers a turbine-driven alternator of the usual type, having a 4-pole revolving field and a stationary armature divided into two parts by a horizontal plane. The joints between the upper and lower halves of the armature, even if made with the utmost care, are always

magnetically imperfect and offer an appreciable reluctance. Hence the field flux will vary between certain limits for different positions of the armature. Since part of this flux passes through the shaft, it follows that during the rotation of the field a certain fraction of the field flux will periodically move across the shaft sideways (*i.e.*, along radial planes) in opposite directions, thereby inducing an alternating e.m.f. along the shaft whose period is equal to that of the main current. The effect can only occur in $4m$-pole machines, where m is an integer. It would obviously not occur in a 2-pole alternator. The authors' theory is confirmed by some results obtained with a 4-pole machine, in which the reluctance of the joints was progressively increased by widening the gaps between the two halves of the armature; the e.m.f. measured across the ends of the shaft was found to increase with increase of the reluctance of the joints, and its value agreed fairly well with the calculated value. The authors allude to the possibility of turning this effect to useful account in the construction of alternators required to furnish very large currents at a p.d. of only about 20 volts or so (as in certain electrochemical operations), and develop the theory of this peculiar type of alternator, in which there would be no special armature winding, the shaft of the machine taking the place of such a winding. The current would be collected by a sufficiently large number of brushes applied to the end portions of the shaft. It is known that the design of such low-voltage machines on ordinary lines presents formidable difficulties. A. H.

1031. *Size, Weights, and Costs of Alternators as affected by Rated Speed and Periodicity.* W. Chappell and T. Germann. (Elect. Engineering, 2. pp. 285–291, Aug. 22, 1907.)—The authors make a study of the influence of the rated speed on the weight and cost of alternators. Designs are given for six alternators of 400, 600, and 1,000 kv.a. each at 100 r.p.m. 50 cycles and 800 r.p.m. 25 cycles. Complete data of these designs are given with tabulated comparisons of the weights and costs. The authors conclude that for machines of equal output the high-speed low-periodicity machine is the best as regards ease in designing, weight, initial cost, as well as requiring lighter foundations with consequent reduced initial cost and considerably less headroom. A. G. E.

1032. *Short-circuiting Device for Wound Rotors.* (Brit. Pat. 11,238 of 1906. Engineering, 84. p. 228, Aug. 9, 1907. Abstract.)—The slip-rings are mounted on a common carrier, and are held together by horizontal bolts, which are bored out to receive the split contact-pins mounted on the sliding ring which forms the short-circuiting device. Each slip-ring is in metallic connection with one of the bolts. The short-circuiting ring is moved parallel to the shaft by means of a lever, a pin or roller on which engages with a groove in the ring. This lever is connected with the brush spindle in such a manner that, after the short-circuiting ring is moved by the lever, the brushes may be moved out of contact with the slip-rings. The device is the invention of A. B. Clayton. A. H.

1033. *Maintenance of Constancy of Speed by means of Tuning-fork.* (West. Electn. 41. p. 45, July 20, 1907.)—The following method of maintaining the speed of a small motor constant by the aid of a tuning-fork has been patented by E. F. Northrup. The small motor is either provided with slip-rings so that it can act as a rotary converter, or is coupled to an alternator. Included in the alternator circuit is a tuning-fork which periodically makes and breaks

the circuit, thereby momentarily throwing a suitable lamp load on and off the alternator. The torque of the motor is adjusted so that if the alternator were unloaded the speed would exceed that corresponding to the frequency of the fork. The effective load on the alternator will depend on the instantaneous value of its e.m.f. at the instant when the circuit is closed by the tuning-fork. This load will increase in proportion to the driving torque of the motor, but the motor will be kept running at the constant speed corresponding to synchronism with the fork. A. H.

1034. *Interaction of Synchronous Machines.* **M. Brooks.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 823–842, June, 1907.)—The object of this paper is to explain a new circle diagram showing the physical operation of the quantities involved when a generator is driving a synchronous motor. A bipolar diagram is employed, excitation and current being measured radially in suitable scales. In the usual form of V-curve the plotting is by rectilinear co-ordinates, and is very laborious. The circle diagram, on the other hand, can be rapidly constructed by ruler and compasses. If the curves are constructed from experimental data, two observations at given loads will determine the circle with considerable accuracy. To determine the V-curves, however, we must make many observations. A few observations carefully plotted on a circle diagram serve to determine the constants of a transmission line or of a machine even better than the usual "synchronous impedance" tests. The use of the circle diagram is not confined to two single-phase synchronous machines. Two or three phases may be represented. The calculations and diagrams assume sine curves of e.m.f. and current, and hence some allowance has to be made for distorted waves. A. R.

1035. *Theory of Alternate-current Motors.* **H. Görges.** (Elektrotechn. Zeitschr. 28. pp. 730–738, July 25; 758–762; Discussion, pp. 771–774, Aug. 1, 1907. Paper read before the Verband Deutsch. Elektrotechniker, Hamburg. Écl. Électr. 52. pp. 302–306, Aug. 31, 1907, *et seq.*)—The author develops a general theory of alternate-current motors, applicable to every type. The theory is based on the assumption that the magnetic flux is distributed according to the sine law around the circumference of the rotor. On this assumption, the composition and resolution of fluxes may be effected by the simple parallelogram law. For the sake of simplicity the author considers the case of a two-pole motor. Two rectangular axes of reference are chosen, one of which, the *x*-axis, coincides with the magnetic axis of the stator winding. Any flux entering the rotor is regarded as made up of two components, whose directions are along the *x*-axis and the *y*-axis. In any rotor coil there are in general at a given instant four induced e.m.f.'s; two of these are transformer e.m.f.'s, due to the variation of the *x* and *y* components of the flux through the coil, while the remaining two are rotation e.m.f.'s, due to the rotation of the coil in the flux components. The coil itself may be supposed replaced by two component coils having suitable numbers of turns, the axes of these coils being along the two axes of reference. If the rotor has a short-circuited winding—such as the squirrel-cage winding of an induction motor—we may suppose it replaced by a commutator winding, and two pairs of independently short-circuited brushes provided, one pair being arranged along the *x*-axis, the other along the *y*-axis. If the two flux components be known, the e.m.f.'s along the two axes are easily calculated. Similarly, the torque may be calculated if the currents along the two axes are known; the torque being regarded as made up of two com-

ponents, one of which is due to the action of the x-component of the flux on the ampere-turns along the y-axis, and the other to the action of the y-component of the flux on the ampere-turns along the x-axis. The author classifies alternate-current motors according to the nature of the rotor currents along the two axes, such currents being divided into free, externally influenced, and forced currents. *Free* currents circulate in windings which are simply short-circuited on themselves; such currents are due to the induced e.m.f.'s. If an e.m.f. from some external source be injected into the rotor winding (as is done in Heyland's compensated induction motors and some other types), the rotor currents become *externally influenced*. Lastly, if a current of definite magnitude is forced to flow through the rotor, quite irrespective of the e.m.f.'s induced in the rotor winding (as in the case of a series commutator motor), the current may be termed a *forced* current. The above method of investigation is applied in detail to the four leading types of motor: the induction, the series, the Winter-Eichberg, and the repulsion motor. The paper concludes with some general considerations regarding voltage, size, and weight, regulation, commutation, and frequency. In the case of a system intended to deal with a lighting as well as a railway load, the author recommends a frequency of 25. [Ibid., p. 936. Misprints in equations corrected.] A. H.

1036. *Notes on Transformer Testing.* **H. W. Tobey.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 963–973, June, 1907. West. Electn. 41 pp. 168–169, Aug. 31, 1907. Abstract.)—Describes the methods best adapted for determining conversion, polarity, resistance, copper loss, core loss, and exciting current, regulation, insulation resistance between windings and iron, and that between layers and turns of the same winding, temperature-rise. In determining core loss and exciting current the author points out the necessity of using some standard kind of wave-form. E. C. R.

1037. *Heating Effect of the Armature Currents in Rotary Converters.* **J. H. Hunt.** (Electrical World, 50. pp. 170–173, July 27, 1907.)—A formula for the average heating of the armature of a rotary with n slip-rings when the power-factor is $\cos\psi$ is obtained. In the following table the power-factor ($\cos\psi$) at which the rating of the rotary equals that of a direct-current generator is given when the number of slip-rings is n:—

n	3	4	6	12
$\cos\psi$	0·854	0·784	0·741	0·715

In order to check the calculations two heat runs were made on a small 2-phase 4-pole 60-cycle rotary converter, having a nominal rating on the direct-current side of 10 kw. at 125 volts. Power was supplied through four slip-rings on the alternating-current side, and a 3 hours' run was made under the following conditions. The input was 47·5 amps. at 89 volts, the power-factor being 0·785, so that the power was 3·32 kw. The speed was 1,200 r.p.m., the field excitation 0·66 amp., and the output 48 amps. at 114 volts. The rise in temperature of the commutator was 64° F., and of the core 50° F. The machine was then run as a direct-current generator, the brushes being moved forward so as to obtain good commutation. The current and voltage were maintained constant at 48 amps. and 114 volts for 3 hours, the speed being the same as in the preceding test, but the excitation was 1·08 amps. The temperature-rise of the commutator was 61° F. and of the core 49° F., which are sufficiently nearly equal to the preceding results to show that the theory is useful in practice. A. R.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

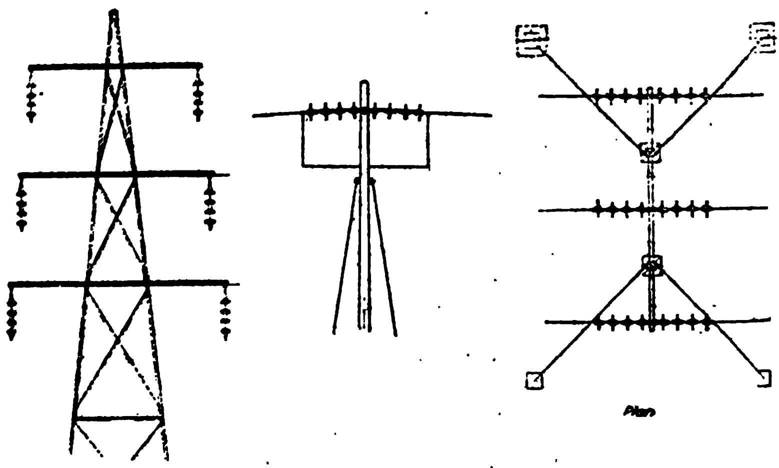
ELECTRICAL DISTRIBUTION.

1038. *Hydro-electric Power* versus *Steam*. **H. v. Schon.** (Eng. Mag. 33. pp. 35–48, April; 184–194, May; 358–380, June, and pp. 611–622, July, 1907.) —In this series of articles the author examines the relative values of fuel and water-power as prime sources of energy. First the availability and reliability of the two agents are compared, to the advantage of water-power; next the adaptability of the power to industrial uses is considered, electric transmission of power from hydro-electric plant being compared with mechanical transmission from steam plant; efficiency is then dealt with, and the cost of power is discussed. In the second article the author gives a list of American cities supplied with hydro-electric power upwards of 1,000 h.p., and the distance of transmission. It is expected that by 1910 there will be an aggregate of 2¼ million h.p. of developed water-power. The available market for power supply, the effect of load-factor upon the design of a plant, and the price to be charged are then considered. Data of the cost of steam power in the Province of Ontario, Canada, are given, and it is stated that with installations up to 50 h.p. working 10 hours per day, with coal at 10s. per ton, the cost is 2¼d. per h.p.-hour or more, falling to 1d. in large installations of high efficiency. The political and physical aspects of water-power development are next dealt with, caution in determining the available flow, and in estimating the costs and probable receipts, being strongly urged. The third article contains illustrated descriptions of three recent installations, and a list of undeveloped water-powers. The Sault Sainte Marie plant consists of 80 generating sets, of 50,000 h.p. [see Abstract No. 808 (1908)]. The Georgian Bay Power Co.'s plant includes a hollow reinforced concrete dam, and has an output of 2,500 e.h.p. at 18,000 volts, which is transmitted to Owen Sound, 38 miles away. The third plant is that of the Patapsco Electric Manufacturing Co., which also has a hollow dam; in this case the generating plant, of 1,650 h.p., is situated in the interior of the dam. The concluding article deals with general considerations relating to water-power development, many data of cost being given. A. H. A.

1039. *Power Transmission*. **F. G. Baum.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 743–757, May, 1907.)—In the early stages of development inexpensive methods must be adopted. For small loads the California Gas and Electric Corporation runs a single wire to a transformer with earth return, using single-phase motors. For loads up to 500 kw. two wires are run, with earth return, for three-phase working, and a load up to 1,500 kw. 100 miles distant can be carried by two transformers with three-phase connections. Duplicate transmission lines are commercially impracticable except for heavy loads. Wood pole lines are reliable and cheap, and by taking advantage of hills very long spans—over 2,000 ft.—can be carried on 80-ft. poles. When reconstructing old lines with short spans, alternate poles may be omitted and the remainder lengthened with ironwork at small cost. Cheaply made oil switches are giving satisfaction on 1,000 miles of line at 60,000 volts, with

generators of 50,000 kw. connected. For small substations and for line section switches simple air-break outdoor switches are used. Illustrations are given of the cheap apparatus employed in California. A. H. A.

1040. *High-pressure Transmission Line Construction.* **H. W. Buck.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 981–987, June, 1907. Elect. Rev., N.Y. 51. pp. 94–96, July 20, 1907.)—The author describes a new system devised by himself and E. M. Hewlett, in which the usual insulators are replaced by series of insulators in tension; the line conductors are either suspended from the cross-arms by these or are dead-ended and secured to the supports by a string of insulators held together by steel links, the ends of consecutive spans being connected by jumpers hung below the insulators. Illustrations are given of designs for a 100,000-volt line carrying 50,000 h.p.



165 miles, with spans 500 to 1,000 ft. long, and other installations. The number of insulators in series depends upon the voltage, the insulators being identical for all voltages. For such high pressures the ordinary insulators have to be very large and costly, and the stresses on the pins and arms are very severe, owing to the great length of the pins. With the new arrangement the insulation can be increased indefinitely without increasing the space occupied on the tower, the insulators are completely exposed to the cleansing action of the rain, a single insulator can be broken without earthing the line, and can be replaced at small cost, and the line is less likely to be struck by lightning, being below the cross-arm. Two modes of link suspension are shown in the Figs. here reproduced. A. H. A.

1041. *Economical Spans for Transmission Lines.* **D. R. Scholes.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 695–711, May, 1907.)—A method is given by which the most economical construction of a transmission line with steel towers can be arrived at. The author resolves the weight of a steel tower of given type into three components, corresponding respectively to the stresses due to wind pressure, to external loads, and to the weight of the tower itself, and develops a general equation for geometrically similar structures which facilitates the calculation of the weight of the tower to suit various spans

when one size has been fully worked out. A concrete example is then taken, and after showing that for the assumed conditions, with a span of 500 ft., a ratio of width of base to height of 1 : 4 is the most economical, the author applies the formula to obtain the most economical length of span, which in this case is 425 ft. The cost of foundations per 1,000 ft. of line is nearly constant at £20; the cost of insulators diminishes, and the cost of the tower structure increases, as the span increases, the curve of total cost passing through a minimum value. The insulators cost about 21s. each erected, and the tower structure about 19s. per 100 lbs. weight. The combined cost is about £52 per 1,000 ft. of line. Numerous curves and data are given.

A. H. A.

1042. *Protection of Transmission Lines against Lightning.* N. Rowe. (Amer. Inst. Elect. Engin., Proc. 26. pp. 718–722, May, 1907.)—The author gives an account of lightning troubles on a steel-tower line in Mexico. The conductors were originally fixed at the corners of an equilateral triangle with 6-ft. sides, the apex upwards, without lightning rods; the line voltage was 60,000 volts, and the length of the line was 101 miles. Storms are very frequent in the rainy season, and at first the lightning discharges perforated the top insulators; lightning rods were erected on the poles, projecting 6 ft. above the top insulators, and gave some relief. Over a great part of the line larger insulators were installed, the uppermost conductor was removed to one side, below one of the others, and an earthed steel cable was erected in its place; where this was done no further trouble was experienced through broken insulators. The author recommends insulators with a high margin of safety, situated out of the path of discharges going to earth by the supporting structure, an earthed cable above the transmission wires, and lightning arresters along the line at frequent intervals.

A. H. A.

1043. *The High-tension Direct-current System.* (Elektrotechnik u. Maschinenbau, 25. pp. 473–477, June 23, 1907. Electrician, 59. pp. 592–598, July 26, 1907. Rev. Électrique, 8. pp. 39–42, July 30, 1907.)—An anonymous criticism by a "well-known English engineer" of Highfield's paper [see Abstract No. 681 (1907)]. Highfield puts the total cost of the direct-current cable required in the particular case he considers as £580 per mile, which is 1·57 times greater than that for the material alone. This factor will be greater for the three-core cable, and may be taken as 1·8. Highfield puts the cost of the two three-core cables required at £1,050 and £900 per mile. They are said to cost in reality only £784 and £608 per mile. The critic says the total cost of the scheme is £107,000 for direct-current and £141,000 for three-phase—a difference of 32 per cent. Highfield makes the relative costs £124,820 and £199,000—a difference of more than 60 per cent. The employment of direct current is only to be recommended when the network expenses are small compared with those of the three-phase system. In the critic's opinion the greater part of these economies are imaginary, and would in no case cover the higher costs of the direct-current generating station.

A. R.

1044. *Rotary Converter Substations.* R. F. Schuchardt. (West. Soc. Engin., Journ. 12. pp. 373–402; Discussion, pp. 403–408, June, 1907.)—The author gives a detailed description of the arrangement and connections of a typical rotary converter substation fed with three-phase current at 9,000 volts, adding brief explanations of the theory and mode of operation of each item

of the plant, with numerous illustrations. In the *discussion*, **E. F. Smith** said that by careful maintenance the life of carbon brushes had been raised to four years. There were 480 brushes on a 2,000-kw. converter, and they had to be very accurately set, with alternate sets of positive brushes staggered so as to cover the whole surface of the commutator, as heavy currents transferred copper from the commutator to the faces of the positive brushes, and thus tended to set up grooving. Carbon brushes should have a pressure of 1·83 lbs. per sq. in., and copper brushes on slip-rings 1·5 to 2 lbs. The current density for the former should be about 80 amps. per sq. in., and for the latter 50 amps. A complete row of carbon brushes should be treated with oil and distributed in the brush-holders so as to cover the whole commutator. Collectors and commutators required turning every five to ten years. The maintenance in good condition of the air-blowers for the transformers was very important. When shutting down converters that were usually started from the direct-current side, the field circuit should be kept closed to demagnetise the transformer cores, otherwise there might be difficulty in starting. After a general shut-down the converters might be started up in connection with the generators, additional converters being started from the direct-current side as the speed rose. Machines of 11,000 kw. had thus been started from rest, and others added, to a total of 80,000 kw. before full speed was reached. A 1,000-kw. converter could be started from the direct-current side in 1½ min. **P. Junkersfeld** stated that vertical-shaft converters of 2,000 kw. were in course of construction. A. H. A.

1045. *Alternating-current Distribution.* **A. J. Cridge.** (Elect. Engineering, 2. pp. 27–29; Discussion, pp. 30–31, July 4, 1907. Paper read before the Municipal Elect. Assoc., Sheffield, June 28, 1907. Electrician, 59. pp. 511–512; Discussion, p. 512, July 12, 1907. Abstract.)—A description is given of some of the results obtained recently on the Sheffield system. The number of electric motors connected with the mains is 881, aggregating 7,000 h.p., or 5,250 kw. The supply is alternating current, single- and two-phase. The frequency is 50, and the supplied pressure is 200, 400, and 2,000 volts. A *résumé* is given of alternating-current theory, particular stress being laid on armature reaction and the importance of a high power-factor. Tables are given of tests under working conditions of a 120-h.p. induction motor driving a direct-current generator and of a 1,500-kw. Parsons turbo-generator at Neepsend. Before 6 p.m. the power-factor of the load on the Parsons machine is about 0·7, but after 6 p.m. it rises to well over 0·9. It is stated that a difference nearly always exists between the readings of two single-phase wattmeters connected in a two-phase power supply. The difference is greater when the motor is running lightly loaded, as in this case the power-factor is smaller. It frequently happens that the readings of the meter in one phase are five or six times as great as the readings of the meter in the other phase. Sometimes also one of them runs backwards. A rotary condenser of 600 kv.a. capacity is about to be installed at Sheffield, and a power-factor indicator will also be used. During the early part of last year the experiment was tried of running a 800-kw. Parsons turbo-generator at the power station as a synchronous motor with an over-excited field. The greater carrying capacity of the mains in this case proved that a rotary condenser would be a desirable adjunct to the station. A. R.

1046. *Effect of Wave-shape on Efficiency of Power Transmission.* **C. F. Holmboe.** (Elektrotechn. Zeitschr. 28. p. 718, July 18, 1907.)—In order to

illustrate the importance of wave-shape in connection with power transmission the author mentions the following case, which came under his observation: A 200-kw. motor-generator set, consisting of a continuous-current motor coupled to a three-phase generator, was employed to transmit power at 5,000 volts to a precisely similar set at a substation 8 km. away, where the three-phase current was transformed into continuous current. The full-load efficiency of either set was 84 per cent., and the power-factor with suitably adjusted exciting current was practically unity. After a time the first motor-generator set was replaced by a steam-driven three-phase alternator of different construction, giving a different form of wave. The efficiency of the substation set was found to have dropped to 79 per cent., and it was found impossible to adjust the power-factor to unity (it fluctuated between 0·91 and 0·98). The great loss of efficiency was due to the increase in the hysteresis and eddy-current losses occasioned by the presence of a resultant third harmonic. The reduced efficiency of the substation set, together with the increased loss in the line due to the reduction in the power-factor, represented a serious pecuniary loss to the supply company. A. H.

1047. *Neutral Currents of Earthed Three-phase System.* **G. I. Rhodes and C. F. Scott.** (Elect. Journ. 4. pp. 882–888, July, 1907. Electrical World, 50. p. 186, July 20, 1907.)—The author points out the danger of large idle currents in generating systems consisting of several star-connected generators having their neutrals earthed, even if the load be Δ-connected. If the e.m.f. waves of such generators are not exactly similar or in phase with each other, local currents will result. Part of the local current will consist of the fundamental and those harmonics which are not multiples of three, and this current will circulate between the machines, passing through the bus-bar connections, but not through the neutrals. On the other hand, the third harmonic and its multiples will pass through the bus-bar connections and the neutrals. Reference is made to the troubles experienced in connection with the Interborough Rapid Transit Co.'s plant at New York [Abstract No. 1827 (1906)], and oscillograms are given showing the local currents and their effects. A. H.

1048. *Protection of Transformers against High-voltage Surges.* **S. M. Kintner.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 685–688, May, 1907.)—Two modes of protection are available, one of which consists in providing specially heavy insulation on the end turns of the transformer winding, and the other in connecting a suitable choking coil between the transformer and the line, the insulation of the transformer winding being uniform. The author discusses the relative merits of these two modes of protection, and pronounces in favour of the choking-coil method, for which he claims the following advantages: (1) In a choking coil there is normally negligible voltage between turns, and hence no tendency to maintain an arc in case of a momentary surface discharge; (2) a transformer having uniform insulation (and therefore of cheap construction) may be used; (3) a choking coil may be insulated much more strongly than a transformer. The only disadvantages connected with the use of separate choking coils are an increase in the number of pieces of apparatus and greater complication in the station wiring. These disadvantages are materially reduced when it is permissible to mount the choking coils in the transformer tank; up to the present the usual practice has been to provide a special oil tank for each choking coil, but the author favours the placing of the choking coil in the transformer tank.
A. H.

1049. *Use of Transformers for Charging Mains.* **G. Benischke.** (Elektrische Kraftbetr. u. Bahnen, 5. pp. 408–410, July 24, 1907. Elect. Engin. 40. pp. 238–239, Aug. 16, 1907.)—The use of a variable reactance in switching cables into circuit is inadmissible, since if the maximum value of the reactance exceeds the capacity reactance of the cable, then as the variable reactance is gradually reduced it will at a certain point become equal to the capacity reactance, and resonance will set in. In order to carry out the switching-on operation safely, two methods are available. In the first, a small auxiliary generator is used by means of which the cable is gradually raised to the p.d. of the mains; this generator is then paralleled with the bus-bars, to which the cable is transferred, and the auxiliary generator switched off. This method is costly and cumbersome. In the second method, the voltage across the cable is gradually raised by means of a variable non-inductive resistance. The objection to this method is the necessity of handling a rheostat in the high-voltage circuit—an arrangement attended with danger to life. The author proposes substituting for the non-inductive resistance a transformer whose primary is included in the high-voltage circuit (being connected in series with the cable), while its secondary is closed through a suitable variable non-inductive resistance. By gradually reducing this latter, the cable is brought up to full voltage, the primary of the transformer being finally short-circuited. A. H.

1050. *Mechanical Design of High-tension Switch-gear.* **H. W. E. Le Fanu.** (Inst. Civ. Engin., Proc. 168. pp. 1–34; Discussion and Correspondence, pp. 35–59, 1906–1907.)—After a brief historical sketch, the author proceeds to discuss examples of modern switch-gear from a mechanical point of view. He takes first a switchboard for 600 kw., with remote control by rods, the high-pressure apparatus being fixed in brick compartments. Next a 8,000-kw. installation of similar type is described. Details of a 8,000-kw. oil circuit-breaker working at 10,000 volts are then given, and the Ferranti long-pull solenoid, which by means of two coils and cores gives a stroke of 10 in., with a pull of 180–400 lbs., is described. For heavy circuit-breakers operated by hand, the levers should be carried by the floor girders, not by the switchboard framework. In stations of large capacity the switch-gear must be arranged in galleries to provide sufficient headroom; the author gives details of the apparatus and its mounting, with illustrations. The ring-main system of high-pressure bus-bars is not recommended for large stations; the bars should be subdivided, each section being fed by one or more generators, and supplying one or more groups of feeders. All ironwork and metal casings should be efficiently earthed, as well as idle bus-bars on which work is being done. The apparatus for controlling the machines should be separated from the meters, relays, &c., and mounted in the position most convenient for the operator; it is advisable to provide direct-control gear near the main circuit-breakers as a reserve, in addition to the central remote-control apparatus normally used. A control column, with circuit-breaker and meters, should also be placed near each generator. Switch-gear for auxiliary machinery should be subdivided, and stand-by excitation should be provided. All cabling belonging to the switch-gear should be continuously insulated and covered with asbestos braiding. Cable trenches should be carefully planned before building is commenced. The dimensions of all parts of the switch-gear, bus-bars, &c., must be liberally designed. In the *discussion*, **L. Andrews** supported the author's views, and remarked on the advantages of the unit system of design in starting-up after a complete shut-down, each alternator being connected to a section of bus-

bar supplying a group of feeders. **A. P. Trotter** advocated greater simplicity in switch-gear, with mechanical control. He was suspicious of oil in switch-gear; gravel should be laid under the oil boxes to absorb burning oil, and in the case of transformers drains should be provided to carry the oil outside the building. **B. M. Jenkin** objected that the oil was sprayed and exploded by the arc, and said that high-pressure compartments should be provided with doors. Separation of phases might be carried too far, and the slow closing of electrically-operated switches made synchronising difficult. **J. E. Woodbridge** remarked that switch-gear cost too much—even £10 per kw. in one case; the complication was a hindrance in emergency. He preferred to use the minimum amount of switch-gear and bus-bars, and to place the gear within easy access of the operator. **R. C. Roberts** pointed out the advantages of earthed steel framework; a leak might charge a wall 20 yards from the switch-gear if no metal were used. Static earth-detectors were preferable to transformer voltmeters. Solder should be avoided in switch-gear. **K. W. E. Edgcumbe** had found condensers in series with electrostatic voltmeters unsatisfactory. The **Author** replied to the points raised. By *correspondence*, **H. W. Clothier** advocated a return to greater simplicity. He thought the long break in the Ferranti circuit-breaker excessive and disproportionate. Cable-charging gear was in his opinion unnecessary, and duplication of parts should be avoided. **G. W. Partridge** objected to modern complication, and to automatic circuit-breakers on generators. The positions of the switches should be mechanically indicated. He had found cable-charging gear very useful. **B. Rowe** dealt with a number of details. **M. Vogelsang** said that separate oil tanks were not used for each phase in Germany. There and in America push-buttons were used to control electrically-operated circuit-breakers. He thought cable-charging gear unnecessary. He recommended the adoption of 110 volts as standard for exciters, and objected to direct-coupled exciters. A. H. A.

1051. *Switchboards for very High Pressures.* **S. Q. Hayes.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 989–1018, June, 1907.)—The paper deals with pressures above 88,000 volts, at which pressure ordinary apparatus becomes unsuitable. A control desk and instrument frame for an 88,000-volt plant of 80,000 kw. is described; the circuit-breakers, regulating rheostats, and field switches are all electrically operated from this desk, which is provided with a miniature bus-bar system to indicate the state of the connections. The comparative advantages of different types of oil circuit-breakers are considered in detail, with illustrations. Generator circuit-breakers are usually non-automatic, though they sometimes have reverse-current relays; the breakers on the low-pressure side of the transformers have overload automatic relays, but those on the high-pressure side are non-automatic. The outgoing lines have automatic overload circuit-breakers. Disconnecting switches are of the plain knife pattern, mounted on high-pressure insulators, and are operated with a pole. Lightning arrester choke-coils have to be immersed in oil. The open type of bus-bars and wiring is preferred to the enclosed system by the author, who points out its advantages, with illustrations. Some particulars are given of the switch-gear for a 50,000-kw. station, designed for 100,000 volts, but to be used at first at 66,000 volts, with the transformers connected in delta, and it is suggested that in future stations the transformers and switch-gear will be placed out-of-doors. A. H. A.

1052. *Location of Broken Insulators on Transmission Lines.* **L. C. Nicholson.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 723–733, May, 1907.)—

Injury to a single insulator sometimes renders the whole transmission line entirely inoperative until the faulty insulator is discovered and replaced. Even when long lines are sectionalised by disconnecting switches spaced at regular intervals it is a tedious process to test section after section and then to locate the exact point of failure by patrolling the section. The ordinary loop tests can sometimes be employed. If, however, the fault be a partial one, as, for instance, when an insulator becomes defective by puncture, these tests cannot be employed, as a high voltage is necessary to produce any current flow. The author describes a test suitable for everyday working. The particular plant on which it has been applied transmits three-phase power at 60,000 volts with a frequency of 25 over a line 160 miles long. The line conductors are of aluminium, spaced 7 ft. apart, and are carried partly on steel towers and partly on wooden structures. The step-up transformers operate mesh-star with neutral grounded. Hence when an insulator breaks down, the arc between the line and the insulator pin is maintained and further service cannot be resumed until the insulator is replaced. To locate a fault, a loop is formed by connecting the faulty line in parallel with one of the others. A high-tension voltage is applied to this loop at the generating end, and the currents in the main and the two branches of the loop are noted. The ammeter readings, together with the known electrical constants of the line, serve to locate the fault. Proofs of the requisite formulæ are given. It is necessary to put a resistance in series with the loop. Ordinary cement concrete columns supplied with expanded metal terminals make a cheap and very satisfactory form of resistance for high-tension circuits. Four columns, 12 ft. long, 1 sq. ft. in section, each having a resistance when cold of about 2,000 ohms have been used singly or in parallel. The temperature resistance coefficient of concrete being large and negative, it is an easy matter to arrive at a proper resistance by heating the columns, by letting the current pass through them. It has been found that as a rule a 1,000-ohm concrete resistance on the high-tension side does not prevent flashing of a broken insulator, and it permits of satisfactory current readings. Occasionally a comparatively low resistance must be used to maintain the arc. The longer the striking distance and the less complete the fault the larger the current required. The effect of the arc upon the cable is an important consideration. If it is burned so as to require splicing, considerably more time is consumed in restoring the line to service than if only a broken insulator has to be replaced. Damage to the cable by an arc carrying 100 amps. for 40 sec. has been found to be trifling when the striking distance is several inches. A record is given of the faults located by the two-ammeter method, and in no case is the error greater than a fifth of a mile—generally only a few hundred feet. The time taken by the test is only about 30 min. If there was a fault on the two lines making the loop the test would give an erroneous result. This case, however, has not yet arisen, and is very exceptional. A. R.

1053. *System of Fault Localisation.* **F. Schultz.** (Elektrotechn. Zeitschr. 28. pp. 739–740, July 25, 1907. Écl. Électr. 52. pp. 387–388, Sept. 14, 1907.)—According to the author's experience, any damage to, or fault in, a distributor is accompanied by the blowing of one or more fuses in the distributing network, so that the problem of localising a fault reduces itself to that of localising the blown fuses. The following method has been patented by the author (D. R.-P. 181,456). Each feeder is provided with a pilot wire, and the connection between the two at the feeding-point is made in such a manner that the blowing of any fuse between the

feeder and a distributor destroys the connection between the feeder and its pilot wire. One method of doing this is to make the connection by means of a fine wire stretched immediately above the fuses, so that the arc formed by the blowing of a fuse melts the wire and breaks the connection. The pilot wires running back from the various feeding-points to the station are connected to a multiple-contact voltmeter switch, so that by moving the switch-arm over the various contacts until a pair of contacts is reached across which no reading is obtained, the feeding-point in the immediate neighbourhood of the fault is localised. A. H.

1054. *New Type of Insulator for High Voltages.* **E. M. Hewlett.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 975–979, June, 1907. Elect. Rev., N.Y. 51. p. 98, July 20, 1907.)—Each insulator, the design of H. W. Buck and the author, is a flanged or petticoated disc with an enlarged central portion having two interlinked semicircular holes crossing each other at right angles; these links are so arranged that the tie-wires which are looped through them are at right angles to one another and exercise a compression strain on the porcelain. Should the insulator break the tie-wires become intermeshed. Several of these discs are suspended from each other in series, the transmission line being suspended from the bottom tie-wire of the lowest disc, while the top tie-wire of the highest disc is suspended from the pole or tower. At distances of about a mile the line must be anchored by attaching its end to the lowest tie-hole of the lowest disc, the beginning of its continuation being treated in the same manner, and the two connected by a loose loop of conductor. [See also Abstract No. 1040 (1907).] E. C. R.

1055. *Need for an Accurate Maximum-demand Meter for Measuring the True Value of Polyphase Service.* **Ferguson.** (Electrical World, 49. p. 1218, with Discussion, June 15, 1907. Abstract of paper read before the National Electric Light Assoc., June 7, 1907.)—The author stated that in Chicago they had practically found it out of the question to use the Wright demand meter for measuring current rather than actual power, and if unity power-factor was assumed it would make the customer's apparent maximum too high. They were working under the following classification: Class A, installations up to 10 h.p.—where one meter is used, 85 per cent. of the connected lead is assumed to be the maximum demand; where more than one meter is used, 75 per cent. Class B, installations from 10 to 50 h.p., irrespective of number of meters, 65 per cent. of the connected load. Class C, installations all over 50 h.p., irrespective of number of meters, 55 per cent. of the connected load. After much discussion the meeting came to the conclusion that there is evidently now no question but that there is need for a cheap demand meter for use on all meter customers. For large meter customers the demand has been met by the watt-hour meter with time-clock attachment. W. J. C.

1056. *Compounded Voltmeters.* **F. E. Haskell, H. B. Brooks.** (Electrical World, 49. p. 1081, May 25, and pp. 1317–1318, June 29, 1907. Elektrotechnik u. Maschinenbau, 25. pp. 574–575, July 21, 1907.)—Haskell describes the following arrangement of a compounded voltmeter for showing the feeding-point p.d. A resistance AB is connected across the station end of the feeder; this resistance is subdivided at a point C so that BC is $\frac{1}{1000}$th of AB. A voltmeter is connected between C and a point D in that feeder conductor which is in connection with the point B, the length BD being such that the voltage drop over BD is $\frac{1}{1000}$th of the total drop along the

feeder. The voltmeter will then give readings proportional to the feeding-point p.d. Brooks has constructed a moving-coil instrument for use as a compounded voltmeter. This has two moving coils, one of which is connected in series with the usual high resistance and then across the feeder conductors, while the other forms a shunt across a suitable length of one of the feeder conductors. The couples exerted by the two coils oppose each other. A. H.

1057. *Mechanical Equipment of Collieries.* **E. M. Hann.** (Inst. Mech. Engin., Proc. 4. pp. 719–733; Discussion, pp. 733–750, Oct.–Dec., 1906. Engineer, 103. pp. 96–98, Jan. 25, 1907. Abstract.)—The lay-out of the Bargoed Colliery of the Powell Duffryn Steam Coal Co. is given. Reference is made to the benefits accruing from the use of the compound engine for winding. Not only is the simple engine much less economical, but there is greater difficulty in getting it speedily to work. Electrical winding is not favoured. The increased capital cost more than neutralises the attendant benefits. New methods for preventing overwinding are touched upon; also different forms of drum. Perhaps the most interesting part of the paper lies in the suggestion that in lieu of a high speed of lifting by journeys, a slow-speed continuous motion should be used, for it is obvious that, if a feasible arrangement of parts could be devised, a comparatively small power would suffice, and it would be almost uniform. This system was in operation on a small scale at Rowley Colliery, near Burnley, but there are great difficulties to be overcome in the mechanical arrangements before it could be a success on a large scale. W. J. C.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

1058. *Battery-room at High Wycombe.* (Elect. Engin. 39. pp. 585–586, April 19, 1907.)—The chief feature is the copper connection work. The switchboard is some distance away from the battery-room, but the battery switches are in the battery-room itself and are operated from the switchboard by means of steel wire ropes. Only 4 copper rods are thus required to be run to the board, instead of 24. L. H. W.

1059. *"Stamp-mill" Reduction Plant of the New Kleinfontein Mine, Witwatersrand.* **E. J. Way.** (Inst. Civ. Engin., Proc. 168. pp. 252–310, 1906–1907.)—Describes the steam and electric generating plant and the use of electric motors for various purposes. In Appendices the cost of the plant is detailed, works and maintenance costs are summarised, and test results quoted. Appendix II. is here reproduced. The following are the works costs per i.h.p.-hour at the New Kleinfontein central power station:—

Hauling engines	with a	load-factor of	20·8	per cent.	cost	0·86d.	per i.h.p.-hour
Electric generators	„	„	40·5	„	„	0·38d.	„
Mill engines	„	„	75·7	„	„	0·37d.	„
Air compressors	„	„	76·0	„	„	0·39d.	„

The works costs averaged over the total output of the plant are 0·428d. per i.h.p.-hour. It will be seen from the foregoing that a large portion of the plant is working under favourable conditions of load-factor, as out of a total of 52,268 i.h.p.-hours per day, 46,088 i.h.p.-hours represent plant running

under a practically constant load, such as the mill engines and air-compressors. The total costs per i.h.p.-hour for the steam power-plant are:—

	Hauling Engines.	Mill Engines, Air Compressors, and Generators.	Average.
	Pence.	Pence.	Pence.
Works cost	0·860	0·380	0·428
Maintenance	0·102	0·102	0·102
Management	0·050	0·050	0·050
	1·012	0·532	0·575
Interest and depreciation...	0·225	0·225	0·225
Total cost...............	1·237	0·757	0·800

L. H. W

1060. *Electrically-operated Gates for the Roosevelt Dam, U.S. Reclamation Service.* **F. W. Hanna.** (Eng. News, 57. pp. 589–591, May 30, 1907.)—The controlling gates being installed at the Roosevelt Dam by the United States Reclamation Service in connection with the Salt River Irrigation Project, are the largest gates in the world operated under the pressure to which they will be subjected. The gates are six in number. They are composed of two sets of three each—the service gates and the emergency gates. The total max. pressure to which each gate will be subjected is about 800,000 lbs. This pressure produces a max. tensile stress in the skin plates of about 2,000 lbs. per sq. in. and a max. compressive stress in the horizontal ribs of about 4,000 lbs. per sq. in. The weight of each gate is 20,000 lbs. For the purpose of raising and lowering, each gate is equipped with a hydraulic cylinder, designed to operate under a max. pressure of 700 lbs. per sq. in., having a piston connected to the gate by means of a bronze lifting rod about 6 in. in diam. and 32 ft. long. One of the unique features of the designs is the automatic arrangement for indicating the position of the piston and the gate to which it is attached. W. J. C.

1061. *Remote Control High-tension Switch-gear of Greenwich Power Station.* **F. Walker.** (Inst. Elect. Engin., Journ. 38. pp. 635–644, June, 1907. Abstract of paper read before the Glasgow Section. Electrician, 58. pp. 919–923, March 29, 1907.)—Description, with connection diagrams and detail drawings, of remote control gear for following: Eight 3,500-kw. (four installed), 3-phase, 6,600-volt, 25-cycle generators (star-connected, centre earthed), twenty-eight 6,600-volt feeders to substation, two 6,600-volt feeders to local substation, two 6,600-volt feeders for station auxiliaries supplied at 220 volts through reducing transformers, two 125-volt, 170-kw. exciters, one battery, and four 500-kw. induction motor-generators for local tramway service. The gear is placed on two galleries parallel to the engine-room, the top gallery containing bus-bars, main switches, and spark-gaps; on the lower gallery are the instrument transformers, a 46-panel low-tension board, the step-down transformers for the station auxiliaries, isolating plugs, and the main control desk. Each generator has a main solenoid-operated oil-switch, and may be connected either to the main bus-bars,

divisible by an interconnecting switch through isolating plugs or to section bus-bars through an oil-switch. On each side of this oil-switch are also isolating plugs. Each length of section bus-bar supplies four feeders. The generators can supply these feeders direct or be run in parallel on the main bars. The large oil-switches are Westinghouse standard solenoid-operated type; energy is supplied for control purposes from a battery at 125 volts. The instrument transformers are placed together in a single oil tank, each tank containing three current and two potential transformers and three high-tension fuses for the latter. Two 8-core cables in steel tubing connect the secondaries with the control board. The main cables enter and leave the tank in a vertical line, so no alteration of direction or bending of the cables is needed. The leads for the control and instrument circuits are run in solid-drawn steel tube. The runs are short, inspection boxes are frequent, and there are no elbows. The reverse-current relays operate on the same principle as induction integrating wattmeters and have adjustable contacts to vary the amount of reverse current at which they shall operate. The overload relays are of the rotating copper disc type, the disc spindle being fitted with a cord and weight. The ratio of rotation is proportional to the current flowing, and the time-lag may be adjusted by altering the length of the cord. Eight panels each control a generator, and sixteen panels each control two feeders; four panels each control two sectional groups of four feeders. Each generator section and feeder panel has red and green indicating lamps. The generator panels are also fitted with signal bell-push, switch-operating engine governors, an emergency push, in glass cover, which must be broken, operating safety gear on engines, and three synchronising sockets. The two synchronising plugs have prongs at different centres so that two machines cannot be short-circuited on the synchronising bars. Six switches are also provided for signalling to the drivers on an illuminated telegraph board. The entire gear was built in accordance with the designs of J. H. Rider by the British Westinghouse Co. W. E. W.

1062. *Philadelphia and Western Railroad.* (Street Rly. Journ. 29. pp. 1052–1065, June 15, 1907.)—The Philadelphia and Western Railroad which was opened for service between Philadelphia and Strafford, Pa., on May 22, marks a step in the development of heavy electric traction for high-speed transportation. The track is at present double, but may be quadrupled in the near future. The striking feature of the power-collecting system is the use of the Farnham inverted U-shape third rail. This conductor is of soft steel, its low proportion of carbon giving it a conductivity equal to an 800,000-circ. mil copper cable, while its bearing surface is equivalent to a 70-lb. T-rail. The transmission is at 19,000 volts, 3-phase. The power generating equipment consists of two 4-stage, 2,000-kw., 3-phase, 25-∿ Curtis turbines. A complete block-signalling system is to be installed.

W. J. C.

1063. *Single-phase Traction in Illinois.* J. R. **Hewett.** (Street Rly. Journ. 30. pp. 4–15, July 6, 1907. Elec. Engineering, 2 pp. 249–251, Aug. 15, 1907.)—The Illinois traction system will in the near future comprise 471·5 miles of track. Of these, 95 miles are at present either being operated, or being equipped for operation, by single-phase current. The general scheme adopted in connection with the single-phase section of the system is as follows: Power is generated by two 2,000-kw., 2,300-volt, 750-r.p.m., 25-∿, 3-phase General Electric Curtis turbo-generators, and is stepped

up to 33,000 volts for transmission purposes. The voltage is then reduced to 3,300 for feeding the trolley wire. The pole line carries both the transmission and the trolley wires. The transmission line will be a duplicate one. The poles are of Spokane cedar, 40 ft. long, having a diam. of 7 in. at the top and 12 to 14 in. at the bottom; they are buried to a depth of 7 ft., the buried portion being embedded in concrete 4 in. thick. The uppermost cross-arm is 4 ft. × 3½ in. × 4½ in., and carries 2 insulators. The next cross-arm is 10 ft. × 3¾ in. × 5¾ in., and carries 4 insulators. The cross-arm for the telephone wires is 4 ft. long. The transmission wires are of No. 2 B. & S. hard-drawn copper. The poles are spaced 140 ft. apart along the straight portions of the line. Protection is afforded by a No. 6 B. & S. galvanised iron wire earthed at every sixth pole, the earth wire being stapled to the poles every 3 ft. In order to reduce the cost of attendance, the substations are combined with waiting-rooms and freight-houses in single buildings. Each substation contains two 200-kw., 33,000–3,300-volt transformers controlled by oil-switches on both primary and secondary sides. Sectionalising switches are provided for the transmission line, and disconnecting switches for the transformers. The catenary form of construction is used for the trolley wire; the messenger cable is 7/16 in. in diam., and consists of 7 strands of No. 11 B. & S. galvanised steel wire. The trolley conductor is a 000 grooved copper wire. The trolley is 18 ft. above the track, and is supported every 46 ft. 8 in. from the messenger cable (there being 3 hangers per span). The track is laid with 70-lb. bonded rails. Each car is equipped with four 75-h.p. (G.E.A.-605) motors wound for a maximum voltage of 250; the motors can be operated with both continuous and single-phase current. The control is of the Sprague G.E. multiple-unit type, and is described in detail. The current collectors are of the ordinary trolley-wheel type, but the trolley base is provided with special insulation to withstand the 3,300 volts.

A. H.

1064. *Single-phase Locomotive of Pennsylvania Railroad.* (Street Rly. Journ. 30. pp. 92–93, July 20, 1907. Electrical World, 50. pp. 117–118, July 20, 1907.)—The Westinghouse Co. is constructing a single-phase, 11,000-volt, 15-∿ locomotive for the Pennsylvania Railroad, to be capable of exerting a maximum of 4,000 h.p. The locomotive is to consist of two separate halves; one of these has already been constructed, and has been subjected to some trials. On the test track at Pittsburg, which is 5 miles long and consists of a succession of curves, a speed of 73 m.p.h. was attained; it is claimed that a speed of 90 m.p.h. can easily be reached on a straight track. The maximum draw-bar pull exerted by this half locomotive was found to be 24,000 lbs. The complete locomotive is to be equipped with four 500-h.p. motors (capable of standing an overload of 100 per cent.), each weighing 20,000 lbs. The normal voltage per commutator is 300, and the power-factor at full-load is 98 per cent. The motors are of the gearless type.

A. H.

1065. *Plant of the Société Méridionale de Transport de Force.* E. Gaisset. (Écl. Électr. 52. pp. 116–125, July 27, and 151–162, Aug. 3, 1907.)—Two systems are used by this Company, one being a 3-phase, and the other a continuous-current system. The first comprises a double 20,000-volt, 50-∿ feeder 65 km. long, and 3 lines at 17,000 volts, supplying, through step-down transformers, about 600 km. of 5,000-volt lines. The continuous-current, three-wire, 2 × 110-volt system is in use at Carcassonne and Narbonne. The

original generating station at Saint-Georges, near Axat (Aude), constructed in 1899, consists of a hydro-electric plant, with a head of 100 m. It contains four 600-kw., 2,800-volt, 10-pole, Alioth alternators (each weighing 85 tons) coupled to Pelton wheels running at 300 r.p.m. Three kinds of lightning arresters are in use—horn, water-jet, and multi-gap. The horn arresters are set to have a 22-mm. gap, and are provided with earthing resistances consisting of a mixture of water and alcohol. The author speaks unfavourably of the multi-gap arrester. Experiments are in progress with the condenser system of protection devised by Mościcki [Abstract No. 1571 (1905)]. In addition to the older continuous-current stations at Carcassonne and Narbonne, the Company has established a new 875-kw., 3-phase steam station at Narbonne, and is constructing a 4,000-h.p., hydro-electric station at Aguzou. The 20,000-volt feeder running out from Saint-Georges consists of three silicium-bronze conductors, each 38 sq. mm. in cross-section, spaced 90 cm. apart. Creosoted wooden poles, 10 m. high, 25 cm. in diam. at the base, and 14 to 16 cm. at the top, are mostly used, but steel poles set in concrete are in use on curves. The span is from 35 to 40 m. The insulators are of porcelain, and have a max. diam. of 175 mm., and a height of 180 mm. They are made in two pieces cemented together with litharge-glycerine cement. A. H

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

1066. *Single-phase Railways.* **F. E. Wynne.** (Eng. Club Phil., Proc. 24. pp. 184–215; Discussion, pp. 215–218, April, 1907.)—The author briefly describes the leading features of electric traction with single-phase motors. In the *discussion*, **J. J. Gibson** stated that the N.Y., N.H., and Hartford Railroad had kept careful records of the cost of maintaining steam locomotives, and found that freight locomotives cost 4·05d. per mile, passenger locomotives 2·8d. On the Valtelina line the electric locomotives cost 0·9d. per mile, and an electric locomotive for the New York Central Railroad which had run 50,000 miles cost less than 0·625d. per mile. In his reply, the **Author** said that comparative trials had shown that steam traction cost 5·8d. per 100 ton-miles, where electric traction cost 3·55d.; and on long runs, 1·15d. for steam, against 0·75d. for electricity. A. H. A.

1067. *Effect of Transmission Line on Reliability of Railway Service.* **E. R. Cunningham.** (Street Rly. Journ. 30. pp. 16–18, July 6, 1907.)—The transmission line must be regarded as forming the weakest link of a railway system. Such lines are generally three-phase, and the breakdown of one of the wires generally cripples the service. The author discusses methods of connecting transformers and starting rotary converters in substations so that a loss of one, or even two, of the transmission wires will not interrupt the service. Discussing the three methods commonly in use for starting rotaries (by applying a reduced voltage to slip-rings, by independent small induction motor, and by continuous current supplied to commutator side), the author expresses the opinion that at least two methods should be provided in each case, one being an alternating-current and the other a continuous-current method. For if one of the transmission wires should come down and the transformers are connected ΔΔ, it will be impossible to start from the alternating-current side. But the rotaries may be brought up to speed from

[1] Non-electrical Automobiles are described in the Section dealing with Steam and Gas Engines.

the continuous-current side, synchronised on one phase and then operated single-phase (at one-third their normal output). The reliability of the service is largely affected by the transformer connections; these may be ΔΔ, YY, ΔY, or YΔ, the first and last being those most commonly in use. With the ΔΔ connections, if a transformer burns out the rotary can still be operated three-phase on open Δ, but if one of the transmission wires has to be cut out, it is impossible to run at all unless the substation is provided with means for starting from the continuous-current side. With the YΔ connections, the rotaries in a substation may not only be operated three-phase with 2 transformers, but three-phase with 2 transmission wires, provided the neutral point of the star is earthed at both ends of transmission line. It is further possible to operate single-phase with only one transmission wire, provided the rotaries may be started from the continuous-current side. The author has successfully started up rotaries from the alternating-current side with only two transmission wires in service, the transformers at the generating station being connected ΔΔ; this is accomplished by having substations on at least two different transmission lines running out from the generating station, the substation transformers being connected YΔ. A. H.

1068. *Accumulator Traction on German Railways.* E. C. Zehme. (Elektrotechn. Zeitschr. 28. pp. 791–796, Aug. 8, 1907.)—Attempts have been made in Germany during the last 15 years to introduce accumulator traction on branch lines along which the amount of traffic is so small as to render the use of steam traction, or of ordinary electric traction with power transmitted along a conductor from a generating station, too costly. Single cars driven by accumulators have given very good results on some of the Bavarian lines, and similar cars are about to be introduced by the Prussian State Railways on certain branch lines. In the older type of car, the accumulators are placed underneath the seats, but in the most recent types now in course of construction they are contained in special compartments arranged at both ends of the car, and are thus rendered much more accessible; a further advantage of this form of construction is that no acid fumes can enter the car. Two sizes of car will be used, the number of cells in each case being 180. The battery weights are 10 and 15 tons, and the maximum length of run obtainable with a single charge, 70 and 100 km. respectively. The total cost of a car-km. is estimated to amount to 50 pf. (6d.); this estimate is based on the assumption of a total life of 120,000 and 80,000 km. for the positive and negative plates respectively. The dynamo at the charging station is driven by a Diesel engine. A. H.

1069. *Electric* v. *Steam Traction for High-speed Trains.* R. Rinkel. (Elektrische Kraftbetr. u. Bahnen, 5. pp. 421–426, Aug. 8, and 447–451, Aug. 14, 1907.)—This is a critical examination of the relative economy of electric and steam locomotives for hauling trains at a speed of 120 km./hour. From a careful study of the performances of the most powerful recently built Continental steam locomotives, the author arrives at the conclusion that the maximum attainable normal output is about 1,500 h.p., and that the speed limit which could be reached by the locomotive if running alone may be put at 150 km./hour. At a speed of 120 km./hour, such a locomotive could haul a train of about 228 tons. The output of the most powerful steam locomotives amounts to about 11 h.p. per ton. In the case of electric locomotives the outputs are 17, 20, and 28 h.p. per ton for single-phase, three-phase, and continuous current respectively. The air resistance of electric locomotives is

only from $\frac{3}{5}$ to $\frac{3}{4}$ that of steam locomotives. Taking the steam consumption of a steam locomotive at from 8 kg. (superheated) to 10 kg. of (saturated) steam per h.p.-hour, and the energy consumption of an electric locomotive at 26·4 watt-hours per train ton-km., the author finds that as regards cost of running there is little to choose between the two systems. He points out, however, that if attempts are made to reduce working expenses, electric traction offers a far more promising field. Of the total working expenses connected with steam railways, about 45 per cent. represents salaries and wages. A saving could probably be here effected, as the driving of an electric locomotive involves far less physical strain than that of a steam locomotive. Again, with electric locomotives much heavier trains could be hauled, and a speed of 120 km./hour could be maintained on most of the existing lines, whereas this would not always be safe with steam locomotives. This would allow of a considerable increase of traffic along busy lines. The author suggests that the Hamm-Düsseldorf section, which is 110 km. long, be selected for high-speed traction experiments, as owing to the large number of coal-pits and smelting furnaces in the neighbourhood a very cheap supply of power could easily be obtained. A. H.

1070. *Stability of an Electric Car.* (Tram. Rly. World, 21. pp. 490–491, June 6, 1907.)—The writer examines the conditions and limitations affecting the car's stability. The views from which he writes are: with the car loaded and unloaded; the effect of wind pressure acting in a direction at right angles to the side of the car; and also when the car is on a curve. From the figures given the following table will show the maximum wind pressure which each type of car will stand without overturning and also the limited speed on a 40-ft. radius curve for gauges of 4 ft. 8½ in. and 3 ft. 6 in.

Particulars of Car.	A.		B.		C.	
	Lb. per sq. ft.		Miles per Hour.		Foot-Pounds.	
	3 ft. 6 in. Gauge.	4 ft. 8½ in. Gauge.	3 ft. 6 in. Gauge.	4 ft. 8½ in. Gauge.	3 ft. 6 in. Gauge.	4 ft. 8½ in. Gauge.
Roof covered—						
Unloaded	15·3	20·6	15·5	18·0	16·6	22·3
Loaded inside only	17·7	23·9	15·4	17·9	19·3	25·9
Loaded outside only	19·2	25·9	13·5	15·6	20·8	28·0
Loaded inside and outside	21·7	29·2	13·6	15·7	23·5	31·6
Open top—						
Unloaded	26·0	35·0	18·1	21·0	14·9	20·0
Loaded inside only	30·5	41·0	17·5	20·3	17·5	23·5
Loaded outside only	33·4	45·0	14·5	16·8	19·1	25·7
Loaded inside and outside	37·9	51·0	14·5	16·8	21·7	29·2

Column A shows the wind pressure in lb. per sq. ft. which would overturn the car when running on a straight level track.
Column B shows the speed in miles per hour round a curve of 40 ft. radius which would overturn the car.
Column C shows the moment in foot-tons resisting overturning.

C. E. A.

1071. *Relation between Maintenance of Track and Equipment of Interurban Lines.* W. R. W. Griffin. (Street Rly. Journ. 29. pp. 1167–1168, June 29, 1907. Paper read before the Street Rly. Assoc. of the State of New York,

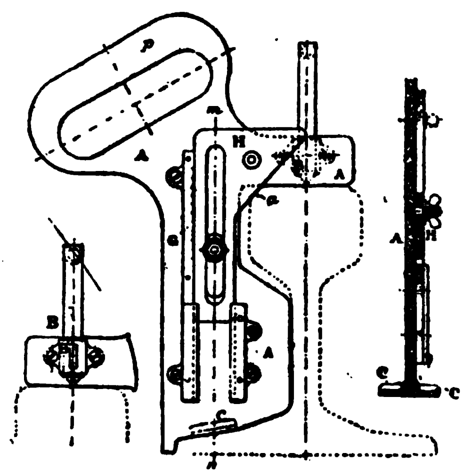
June 25–26, 1907.)—The author comments on the fact that in the majority of papers read and also articles in the various journals, the condition of track is rarely taken into account as having any bearing upon maintenance of equipment of high-speed interurban lines. Rough track with low joints, bad surface and line certainly racks car-bodies and trucks, and is hard as well as dangerous on car-wheels. It is also hard on motors, armatures, and is continually tearing off motor cables. Eliminating painting and damaged cars, in body repairs, since these two items have no relation to track, we have—

	1905—Per 1,000 Car-miles.	1906—Per 1,000 Car-miles.
Maintenance of Cars	$13.59	$8.58
Maintenance of Electric Equipment	5.20	5.42
Track	11.20	15.00
Total	$29.99	$28.98

Making a total saving of $1.01 per 1,000 car-miles.

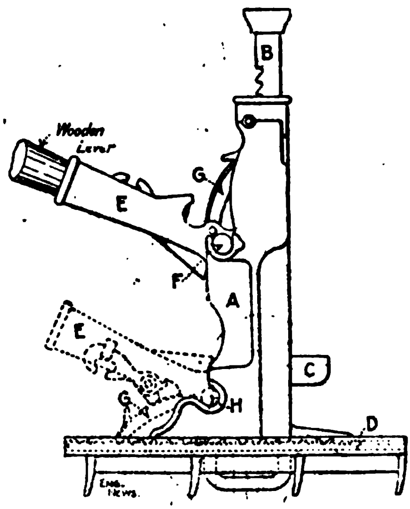
From the foregoing figures the author's opinion is that it is good policy still to increase the ratio of total expenditure on track, since the track is the real permanent part of the railroad, and in so doing we not only build up a far better permanent way, but greatly extend the time of renewal of cars and electrical equipment. C. E. A.

1072. *Apparatus for determining the Wear of Rails.* (Eng. Rev. 16. p. 388, May, 1907.)—The apparatus shown in the Fig. was designed by the engineers of the Paris Metropolitan Railway, to enable measurements of wear to be



made even by unpractised men. The portion A is shaped to fit the rail, and is mounted on the flanges C, and terminates in a handle P, by which it can be applied to the rail as shown. The vertical wear is measured by the graduated cursor B, mounted at the end of the templet A, and sliding in the bracket B′. Lateral wear is given by the difference between the vertical wear and the figure indicated by the cursor on the graduated scale at G. The normal difference between the point of tangency *a* and the tangent horizontal to the running surface, for a new rail, is taken into account; this is a constant which can be allowed for by a single setting of the zero on the scale G. L. H. W.

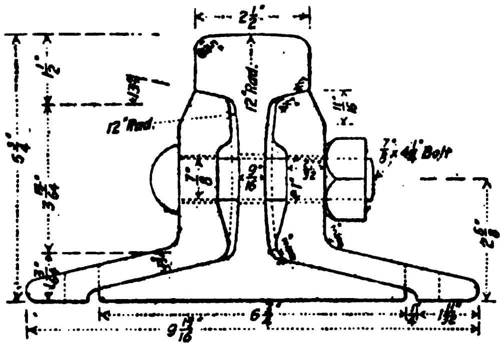
1073. *Lining Track by the Use of Jacks.* (Eng. News, 57. p. 457, April 25, 1907.)—The work of lining railway track is usually effected by a gang of six to ten men with lining bars, but the work is very severe, and in order to obviate this and at the same time to do the work quicker and better than the ordinary lining gang, a special form of track-jack has been devised which has a lateral travel on a bed-plate, in addition to the ordinary vertical lift. The construction of the jack is shown in the accompanying illustration. At A is the frame or pedestal of the jack, with lifting bar at B, on which is the claw or foot C to fit under the rail or tie. The horizontal bed-plate D is of channel section, with a rack in the bottom and having ribs under the bottom which give it a grip in the ballast. The jack proper can be lifted off the base plate, and each part has a handle for convenience in carrying from place to place. The jacks are used in pairs. The ballast is removed from between



two ties to allow the base plates to be pushed under the rails and firmly bedded; each jack is then slipped into the grooves of its base plate and slid along until the foot C is under the rail and the frame bears against the edge of the rail. By means of the lever E working in the upper fulcrum at F, and having a pawl G engaging with the rack on the bar B, this bar is raised until the ties are just clear of the ballast bed (but not enough to allow dirt to fall in beneath them). If the ballast is heavy, it may be loosened around the ends of the ties in the direction the track is to be thrown. The lifting bar is then held in position by a dog or latch while the lever E is removed and set at the lower fulcrum H, the lever being inverted so that the pawl G engages with the rack in the base plate. Then by working the lever the jack is forced along the base plate. With the two jacks used simultaneously the track is readily thrown to line. When the required movement has been made, the lever is again set in the upper socket, and the bar raised slightly to allow the latch to be tripped, thus dropping the ties upon their bed. The jack has a lifting capacity of 12 tons, and weighs 105 lbs. Its height with the bar lowered is 24½ in., and the bar has a vertical lift of 12½ in. C. E. A.

1074. *Experience with Wide-base Rails on the Atchison, Topeka, and Santa Fe Railway.* (Eng. News, 57. p. 657, June 13, 1907.)—It has been suggested

many times that the width of rail base should be increased in order to give a larger bearing surface upon ties, as the wearing and cutting of ties by rails is one of the principal troubles in regard to the life and cost of ties and the work of track maintenance. The difficulties of rolling, however, are increased, and wide-base rails of such good quality are not produced. It is therefore generally recognised that it is better and more economical to use a



rail section in which the width does not exceed the height, and to protect the ties by means of steel or wooden tie-plates. An interesting experiment with wide-base 101-lb. rails has been made on the Atchison, Topeka, and Santa Fe Railway system with results that sustain the statements made above. The results are very satisfactory so far as the effect upon the ties was concerned, but it was found that the rails break very readily in the base. C. E. A.

1075. *Rail Corrugation.* **J. A. Panton.** (Inst. Elect. Engin., Journ. 39. pp. 8–15; Discussion and Communications, pp. 15–28, July, 1907. Electrician, 58. pp. 885–889, March 22; Discussion, pp. 932–933, March 29, 1907. Abstract. Street Rly. Journ. 29. pp. 640–645; Discussion, p. 645, April 13, 1907.) —In this paper details are given of the method employed by the author in investigating the corrugation problem, and of the results which have led him to adopt his present theory, special attention being paid to some of the latest developments. *Rails.*—The author has given careful consideration to the theory that the absence or presence of corrugations depends on the quality of the rail, and has come to the conclusion that no satisfactory evidence has yet been put forward in support of it, and gives the following reasons why the rail theory fails to account for the corrugations: (1) Because rails manufactured by every firm in the world have corrugated since the advent of electric traction. (2) That the rails did not corrugate in the days of horse and steam cars. (3) That the check rails are corrugated to an equal degree, the corrugations being parallel to those on the crown of the rail. (4) That rails did not corrugate so long as the armatures were built on the axle. (5) That it takes on the average three years to develop corrugations on a new system, and only three weeks on relaying with new rails thereafter. (6) That an ordinary railway rail taken from the straight road of an electrically operated railway (where no corrugations occur) and relaid on a checked curve soon corrugates. The next really important point taken up by the author is the excessive wheel and flange wear on electric railways and tramways. The slightest difference in circumference of two wheels on the same axle will cause a deal of trouble, for it results in an unbalanced condition of the car-body. In serious cases this unbalanced condition has caused a cant or tilt of the car-body representing

$\frac{3}{4}$ in. in 9 ft. 6 in. Speaking generally, corrugations are most likely to be found in towns and cities where sharp loops and curves are negotiated regardless of speed with top-heavy canopy-covered cars and trucks that were never designed for such circumstances, consisting of a few stampings and castings bolted together regardless of accurate fitting. Such frames are unable to retain their original squareness, however well reinforced with corner plates. This lack of squareness means axles out of parallel, motors out of alignment, and bearings out of truth, resulting in climbing wheels, hot boxes, unnecessary consumption of power, and rapid deterioration of rolling stock and rails. Some twelve months ago a set of Corporation tramway trucks were put through the engineering shops, thoroughly squared up, planed, fitted, and finished. These trucks were then put on a particular route, and it has been found that the wheel flanges are greatly improved and the corrugations reduced to one-half their original size. To sum up briefly, the author considers that corrugations are caused, directly or indirectly, by lateral play in weak trucks, the weakness being intensified by unsymmetrically driven axles. The whole question can, however, be finally settled and tested only by a full technical investigation carried out by the Board of Trade or a Royal Commission. In the *discussion*, **Carus-Wilson** raised the point of gauge. The gauge is continually varying, and the level of the rails is always changing from point to point—a very small change, but quite enough, taken in conjunction with the question of the difference of gauge, to suggest the possibility that the existence of corrugation at any particular point may be due to irregularity in the track, which causes the car, or the wheels of the car, to make an attack, as it were, upon the rails at that point always in the same way. Also as regards the distorting strains brought to bear on the trucks, producing a permanent deformation of them, he thinks a great deal more proof is required before it can be said that this is certainly the cause of corrugation. **W. W. Beaumont** states that he is unable to find himself in agreement with any part of the paper as an explanation of the cause of corrugation. **W. M. Mordey** remarks that soft rails make corrugation trouble much worse. C. E. A.

1076. *Rail Corrugation.* **W. J. Cudworth.** (Engineering, 83. pp. 763–765, 766 and 767, June 14, 1907.)—Gives the results of experiments made in an attempt to trace the causes of rail corrugation on the North-Eastern Railway. Neither from general considerations nor from the results of tests, analyses, and microscopic examination are any definite conclusions arrived at. The bulk of evidence, however, seems to show that the metal itself is not in the present case at fault. Rails on curves were no more liable to corrugation than those on straight track, and the nature of the ballast seemed to take no part; but there was a slight preponderance of the roaring rails on down gradients. There has not been a single case of fracture of a roaring rail on this railway. The roaring rails were, in seven cases out of eight, mechanically harder than otherwise very similar smooth rails, and on the tops of the corrugations the metal was, as usual, hardest. It seems possible that the action producing the corrugations may be akin to the chattering of tools. The paper is illustrated with photographs, photo-micrographs, and curves. F. R.

1077. *Air-brakes for High-speed Trains.* **Oppermann.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 506–510; Discussion, p. 510, March 30, 1907. Paper read before the Hanover Section.)—The most effective braking is obtained by causing the brake-blocks to exert such a pressure on the wheels

that the resistance to their motion is as near the maximum friction between wheel and rail as is possible. The coefficient of friction is known to be much smaller at high speeds, and hence the maintenance of a constant pressure on the brake-blocks will not by any means imply a constant resistance to turning of the wheels. The new high-speed railway brake designed by the author for the Westinghouse Brake Co. consists of two ordinary quick-acting brake equipments, one serving for the application of a constant pressure of the brake-blocks on the wheels, such that slipping will not take place even at the moment just before coming to rest, and the other being so regulated that it is applied only at the higher speeds, to compensate for the lower friction-coefficient. Tests made in July, 1905, on the Bavarian and Prussian State Railways, on the same train, first with constant pressure (ordinary air-brake) and then with variable pressure (including auxiliary pressure at high speeds) have given the following results:—

Constant Pressure.		Variable Pressure.	
Speed, Km./hour.	Distance Run after Brakes Applied, in m.	Speed, Km./hour.	Distance Run after Brakes Applied, in m.
71·6	241	71·5	169
91·7	411	91·3	264
100·1	507	99	309
109·7	608	109·5	436
120	765	119	536
131	951	129·5	602

L. H. W.

ELECTRIC LAMPS AND LIGHTING.

1078. *Brockie's Carbon-guide for Arc Lamps.* (Brit. Pat. 14,608 of 1906. Engineer, 104. p. 74, July 19, 1907. Abstract.)—In this arrangement the lower carbons are mounted in holders which are provided at their inner sides with projections extending round the flanges into the grooves of an H-section bar arranged in the vertical axis of the lamps. These holders are attached at their outer sides to the inwardly-bent lower ends of rods which slide in the side tubes of the lamp frame. These rods are supported on cords that pass over guide pulleys, and are connected to the upper carbon-holders. The upper ends of the lower carbons pass through fixed guides, so as to enable very long carbons to be used. C. K. F.

1079. *Illumination Problems connected with Mercury Vapour Lamps.* K. **Norden.** (Elektrotechn. Zeitschr. 28. pp. 757–758, Aug. 1, 1907.)—The author expresses the opinion that for workshop illumination mercury vapour lamps are likely to be largely used in the future, experience having shown that the light from such lamps is less fatiguing to the eye than that from any other illuminant. He regards the Aron mercury-vapour lamps manufactured by the A.E.G. as the most satisfactory, owing to the fact that they are provided with a self-lighting arrangement. These lamps have the form of vertical tubes, one size being 500 and the other 1,000 mm. long. In order to facilitate illumination problems connected with the use of such lamps, the author establishes formulæ for the horizontal illumination. In the simpler formula, the entire luminous flux is supposed to proceed from the middle point of the tube; in the more elaborate one, due account is taken of the linear distribution of the source. Comparison of the results obtained by the aid of the two formulæ points to the advisability of using the more accurate one. A. H.

1080. *The Moore Vacuum Tube-light.* (Engineering, 84. p. 58, July 12, 1907.)—A description is given of a Moore vacuum tube installation erected in London at the Savoy Court, Strand; 176 ft. of tube of 1¾ in. diam. is used to form a rectangle for lighting up the court. Nitrogen gas is employed to produce a yellow-pinkish glow. Diagrams showing the essential features of the Moore light and the feeder valve are given in the paper. Continuous current being employed at the Savoy Hotel, it was necessary to put down a motor-generator in order to produce the required alternating current of 60 cycles. The power-factor is about 70 per cent., the tube consuming 2,950 watts. [See also Abstracts Nos. 1088 (1906) and 812 (1907).] L. G.

1081. *Present Possibilities of Metallic Filament Lamps.* (Elect. Rev. 61. pp. 85–86, July 19, 1907.)—In this article a description of an adapter arranged for coupling metallic filament lamps in series when using ordinary sockets is given. Owing to the difficulty of obtaining supplies of lamps of the tungsten group of higher voltages than 130 volts the necessity of using such an adapter has been felt. Where alternating current is used it was found advisable to reduce the voltage by transformers and burn the lamps in series, or to use auto-transformers, similar to those employed for supplying alternating-current arc lamps, in which the internal losses are so low that a large net saving in consumption can be shown. The merits and faults of these metallic filament lamps are described, and the advantages to be derived by using metallic filament lamps in place of carbon lamps are illustrated by a series of numerical examples which demonstrate the superiority of the metallic filament lamp. L. G.

1082. *Production of Metallic Glow-lamp Filaments.* (Brit. Pat. 14,816 of 1906. Engineer, 104. p. 126, Aug. 2, 1907. Abstract.)—According to the process of the Deutsche Gasglühlicht Aktiengesell., crude tungsten filaments are heated to a white heat in an atmosphere of a mixture of nitrogen or [and] hydrogen, in order that the particles sinter together as closely as possible, and to prevent further change in the dimensions of the filament. The employment of alternating current for heating the filaments is found to produce irregular deformations in them which are completely absent when direct current is used. When treating the filaments *in vacuo*, however, alternating current can be used equally well. L. H. W.

1083. *Metallic Filament Lamps.* **J. T. Morris, F. Stroude, and R. M. Ellis.** (Electrician, 59. pp. 584–587, July 26, and pp. 624–626, Aug. 2, 1907. Écl. Électr. 52. pp. 816–820, Aug. 31, *et seq.*, 1907.)—Tantalum, osram, wolfram, and zircon lamps were examined, and it was found that when burning under normal conditions a change of 1 per cent. in voltage caused a variation of 4 per cent. in c.p., as compared with 6 per cent. for carbon filaments. Assuming that when filaments emit light of the same colour they are working at the same temperature, and that the temperature of the carbon filament, taking 3·5 watts per c.p., is 1,727° C., the authors find that the temperature of a tantalum filament is between 1,850° C. and 1,980° C., the absolute temperature being supposed to be proportional to the fourth root of the watts, according to Stefan's law. Similarly the temperature of an osram, wolfram, or zircon filament is about 2,000° C. A method of obtaining the specific heats of these filaments is suggested, and a table is given containing a great variety of physical constants connected with the various filaments. W. H. S.

1084. *Photometry of Electric Lamps.* **M. Buffa.** (Atti dell' Assoc. Elettr. Ital. 11. pp. 211–215, May–June, 1907. Elettricità, Milan, 28. pp. 332–333, May 31, 1907.)—The author proposes to measure all luminous radiation by the thermopile. The light from any source is spread out into a spectrum, the luminous rays alone are recombined by a cylindrical lens and thrown upon a thermopile. The readings of the latter are quite independent of colour. E. E. F.

1085. *Comparison Photometer.* **C. H. Williams.** (Electrical World, 50. p. 287, Aug. 10, 1907. Paper read before the Illuminating Engin. Soc., Boston, July 30 and 31, 1907.)—A compact and portable instrument is described for comparing an illuminated surface with a standard illumination. The surface to be photometered is looked at directly through an opening in the photometer, and the light coming from it passes through the half of a disc, the other half of which is illuminated by light reflected from the photometer lamp. If the disc be not uniformly illuminated the intensity on one side is reduced by means of a movable photographic film until a balance is obtained. The scale on the film gives the illumination due to the object as compared with the standard. The instrument is standardised by adjusting the illumination of a piece of rough white Bristol board by a standard lamp until it is 1 candle-ft. This is then looked at through the photometer and a balance obtained. The illumination produced by the photometer lamp on the ground glass is then 1 candle-ft. The scale can thus be calibrated. A small lamp, with no tip, supplied by a 5-volt battery, is found to make a suitable photometer lamp. The colour difficulty can be partially remedied by placing a light blue glass before the comparison lamp. As photographic films are neutral and non-selective in their colour effects, the colour difficulty is not nearly so serious as in other forms of photometer. The films used are the same as those used in astronomical work in Harvard Observatory. A. R.

1086. *Globe Photometer.* **R. Ulbricht.** (Elektrotechn. Zeitschr. 28. pp. 777–781, Aug. 8, 1907.)—The author considers the precautions which must be adopted in order to reduce the errors due to the framework of the lamp and the screen interposed between the source and the milk-glass observation window to a minimum, and lays down definite rules with regard to the photometry of arc lamps. These rules refer to a globe 1·5 m. in diam.—the smallest size sanctioned by the Verband. The author recommends the division of the globe into two hemispheres by a vertical plane. Both the arc lamp under test and the standard lamp by means of which the constant of the instrument is obtained should be placed inside the globe while any measurements are being made. Two vertical screens are provided—one for the arc lamp, the other for the standard. These screens should lie in a plane distant 30 cm. from the vertical diam. of the globe. The larger screen—that for the arc lamp—should have an area not exceeding $\frac{1}{20}$th of the area of a great circle of the sphere. The upper cap of the globe should be bounded by a circle of 30 cm. radius. The standardising lamp should have its middle point 43 cm. below the equatorial plane, while the arc should be the same distance above it, so that the two sources when viewed from the observation window make angles of $\pm 30°$ with the horizontal. For the measurement of hemispherical intensity the "centre of gravity" of the arc is placed in the plane of the circle forming the boundary of the cap (the latter being, of course, removed). The position of the horizontal plane containing the luminous "centre of gravity" is obtained by finding a horizontal plane whose

upper and lower surfaces are equally illuminated by the source. A special instrument, consisting of a modified grease-spot photometer, has been devised by the author for this purpose. The size of the screen for the arc lamp should be such that: (*a*) In the case of a naked arc it screens off the arc (and its reflector, if present); (*b*) in the case of a diffusing globe the entire globe is screened off; (*c*) in the case of an arc in a clear glass globe the arc, its reflector, and the image of the arc formed by the globe are screened off. The percentage error arising from the screens may be taken to amount to $\frac{80F-100F_1}{\pi r^2}$ in the case of spherical, and to $\frac{50F-100F_1}{\pi r^2}$ in the case of hemispherical intensity determinations; F denoting the area of the large, and F_1 that of the small screen, and r the radius of the globe. [See also Abstract No 772 (1906).]

A. H.

1087. *Future of Electric Lighting.* G. Klingenberg. (Elektrotechn. Zeitschr. 28. pp. 805–808, Aug. 15, 1907. Paper read before the National Electric Light Assoc., New York. West. Electn. 41 pp. 126–127, Aug. 17, 1907.) — The author discusses the probable effect of the introduction of the metallic filament lamp on the future of electric lighting. This effect will not be fully felt until the price of the new lamps has fallen from 8s. (its present value) to 1s. The advent of 220-volt metallic filament lamps is probably merely a question of time, and the author favours the retention of the present voltages as against a return to 2 × 110-volt systems. The metallic filament lamp is sure to displace the small arc lamps now in use taking less than 4 amps. Discussing the changes brought about by the flame arc lamp, the author points out that alternating-current lamps of this type are as good as continuous-current ones; mean hemispherical intensities of 5,000 Hefner units are obtainable with 20-amp. lamps. The importance of mercury vapour lamps is briefly touched upon, and the use of such lamps is said to be increasing on the Continent.

A. H.

REFERENCES.

1088. *Revised Wiring Rules of the Institution of Electrical Engineers*, 1907. (Inst. Elect. Engin., Journ. 39. pp. 233–266, July, 1907.)—[See Abstract No. 702 (1907).]

1089. *Costs of Electricity Supply.* H. R. Burnett. (Elect. Engin. 40. pp. 9–11; Discussion, pp. 11–12, July 5, 1907. Paper read before the Municipal Electrical Assoc. Electrician, 59. pp. 471–473; Discussion, pp. 473–475, July 5, 1907. Abstract.)

1090. *Surges in Continuous-current Networks.* C. Feldmann and J. Herzog. (Elektrotechn. Zeitschr. 28. pp. 810–811, Aug. 15, 1907.)—Referring to Hiecke's paper [Abstract No. 589 (1907)], the authors maintain that his conclusions are wrong on account of the assumption made by him that the conditions which hold good in the case of a steady current are also applicable to surges. A circuit containing iron cores is, in spite of the more powerful damping effect, far more dangerous than a coreless one, owing to the much larger amounts of energy which are called into play.

A. H.

1091. *Inductance of Transmission Lines.* K. W. Wagner. (Elektrotechn. Zeitschr. 28. pp. 673–674, July 4, 1907.)—A paper in which the author shows the inapplicability of the Biot-Savart formula to open conductors, and insists on the necessity of defining inductance with reference to closed loops.

A. H.

1092. *Determination of Power-factor in Three-phase Circuits.* **P. Humann.** (Elektrotechn. Zeitschr. 28. pp. 706–707, July 18, 1907.)—As is well known, the power-factor of a balanced three-phase circuit may be determined from the readings of two wattmeters connected as in the two-wattmeter method of power measurement. In order to facilitate the calculation of the power-factor, tables and a curve are given by the author, connecting the power-factor and the ratio of the two wattmeter readings. A. H.

1093. *Nernst Lamp Resistances for Reducing Variations of Supply Voltage.* **P. Lauriol.** (Écl. Électr. 51. pp. 84–85, April 20, 1907.)—At the Père Lachaise Cemetery an electric furnace used for the crematorium is supplied with current at a voltage which may be anything between 400 and 500 volts. To obviate the laying down of a separate lighting plant or booster, a Nernst lamp resistance arrangement has been adopted with satisfactory results. L. H. W.

1094. *Continuous-current Series Systems.* (Brit. Pat. 16,820 of 1906. Engineering, 84. p. 223, Aug. 9, 1907. Abstract.)—J. S. Highfield has patented an electromagnetically operated automatic device whereby continuity of the circuit will be maintained even if one of the conductors at the generating station should break. A. H.

1095. *Electricity Distribution in Brussels.* **F. Loewenthal.** (Assoc. Ing. Él. Liége, Bull. 7. pp. 51–122, Feb. and March, 1907.)—A very complete account of the plant and methods. [See also Abstracts Nos. 497 (1903) and 829 (1904).]

1096. *Funicular Railway Driven by Electric Motor.* **J. Reyval.** (Écl. Électr. 52. pp. 189–198, Aug. 10, 1907.)—A detailed account of the substitution of an electric motor for the steam engine formerly employed to drive the funicular railway between Lyon-Croix-Pâquet and Lyon-Croix-Rousse. The change has resulted in a considerable saving in the cost of energy. A. H.

1097. *New Electric Locomotives for Metropolitan Railway.* (Elect. Engineering, 2. pp. 337–339, Aug. 29, 1907. Street Rly. Journ. 30. pp. 350–352, Sept. 7, 1907.)—A brief description of the new locomotives at present being supplied to the Metropolitan Railway by the British Thomson-Houston Co. Each locomotive when supplied at 600 volts is capable of hauling a passenger train weighing 120 tons at a speed of 35 m.p.h. on the level, and of starting the same load on a gradient of 1 in 44. A. H.

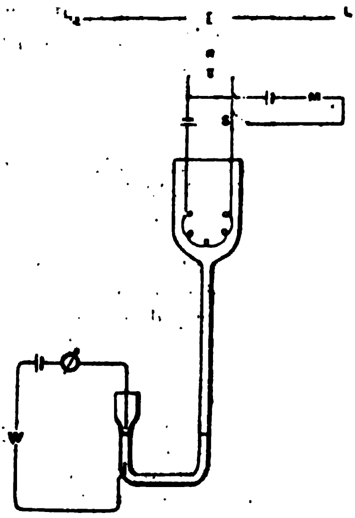
1098. *The Single-phase Series Motor for City Service.* **W. I. Tamlyn.** (Elect. Rev., N.Y. 51. pp. 134–135, July 27, 1907.)—The author discusses the question as to whether the single-phase series motor is capable of competing with its continuous-current rival for ordinary service in towns. He answers the question in the negative, on the ground that the single-phase motor is incapable of giving as high an acceleration—an all-important condition when the starts and stops are frequent. A. H.

1099. *Tierney and Malone's Electrically-operated Tramway Points.* (Engineering, 83. p. 192, Feb. 8, 1907.)—Illustrated description of these points [see Abstract No. 1468 (1905)], which are now made by Brecknell, Munro, and Rogers, Ltd.

1100. *Recent Improvements in Electric Lighting.* **A. H. Bate.** (Inst. Elect. Engin., Journ. 39. pp. 359–360; Discussion, pp. 360–368, Aug., 1907. Abstract of paper read before the Birmingham Section. Electrician, 58. pp. 720–721; Discussion, p. 721, Feb. 22, 1907.)—The question, among others, of cost is considered in connection with the introduction of metal filament lamps.

TELEGRAPHY AND TELEPHONY.

1101. *Hot-wire Relay for Selective Signalling.* **R. Heilbrun.** (Elect. Rev. 61. pp. 287–288, Aug. 9, 1907.)—A relay of any usual type has its coil included in the telegraphic circuit, and when actuated causes currents to be sent through the hot wire of the selective relay. The arrangement is shown in the Fig. The ordinary signalling currents are of too short a duration appreciably to expand the air contained in the glass vessel, and in consequence the liquid rises only very little in the left limb. The quantity of air is too large to be appreciably heated by the short currents, and the apparatus cools off too quickly to render possible the adding up of the



numerous small effects to a large one. The air in the holder expands sufficiently to make the relay respond only in case the Morse key is uninterruptedly depressed for several seconds. The responding is effected by the liquid making a contact when rising in the left limb. The Fig. shows the diagram of connections, key and battery being omitted. L_a and L_b are the line, R the ordinary relay, I denoting its primary contacts, II the secondary ones. The latter lead to the hot-wire relay. As a rule the signalling in the circuit will not affect the hot-wire relay at the principal station. But when any of the stations depresses its key uninterruptedly for a few seconds the hot-wire relay responds and causes the bell, W, to ring. By means of the switch S, the relay is then switched off, and the Morse instrument, M, cut into the circuit. At the end of the communication with the principal station the switch is replaced in its former position. E. O. W.

1102. *Creed's Receiving Telegraph Perforator.* (Elect. Rev. 60. pp. 951–952, June 14, 1907.)—This is a machine which perforates Wheatstone's slip at the receiving or out-station at a maximum rate of about 150 words per min., reproducing an exact replica of the sending tape. The mechanism for

accomplishing this provides for: (1) Actuating punches under the control of, and in correspondence with, the line signals from the tape at the sending station; (2) moving the receiving tape past the punches at a uniform speed approximating to that of the transmitter; (3) momentarily arresting and holding the tape before and during the act of punching, and then releasing it promptly. In order to accomplish (1) and (3) compressed air is used; and for (2) a friction drive for the tape is employed in conjunction with holding and releasing devices described in the paper. Diagram, with explanation, of the parts is furnished. Of course the object of the device is to save manual retransmission. For example, in the ordinary way telegrams from a chief centre A, to a minor office C, have to be received by an intermediate office B, written up and transmitted to C. Here Creed's slip can be passed through the transmitter on the BC line. In the case of press work, B may be the transmitting centre for several offices, and the one received perforated slip can be utilised for automatic distribution, and clerical labour saved. The machine has been operated successfully for over two years. E. O. W.

1103. *Tuning in Wireless Telegraphy.* **O. J. Lodge.** (Elect. Engin. 40. pp. 193–194; Discussion, p. 194, Aug. 9, 1907. Paper read before the British Assoc. at Leicester. Abstracts in Electrician, 59. pp. 754–755, Aug. 23, 1907. Engineering, 84. pp. 237–238; Discussion, pp. 225–226, Aug. 16, 1907.)—Deals mostly with the features embodied in the Lodge-Muirhead system. The author considers that 30 or 40 "swings" in a wave-train, which can easily be obtained with the spark, to be ample for practical requirements; too long a train of waves may give rise to beats and neutralise the effects of the first swings. For a tuned station as opposed to a non-tuned one, a series of points enclosed in ionised air, so as to maintain conduction as long as possible, is desirable. An alternator giving a high-shouldered curve [Blondel] is also of assistance. Referring to the effect of the earth, the author points out that in his arrangement of two superposed capacity areas (horizontal frames), there is an optimum position for the *lower* area. If raised above this the arrangement radiates less strongly; if lowered, the wave-train is shortened until, when allowed to touch the earth—or still more so if connected to it—the discharge is almost dead-beat. As regards tuning so as to receive from a distant tuned station, the tuning is first effected by means of the thermo-galvanometer and then the receiving apparatus made insensitive so as only to respond to the top of the curve; diplex telegraphy is in this way possible with a 5 per cent. change of frequency. *Ratio of received to emitted energy.*—Theory shows that the ratio of the received to emitted energy depends on the cube of the linear dimensions of emitter and receiver (if alike), and on the cube of the distance between them. Measurements with the thermo-galvanometer confirm this estimate approximately, the value in one case being 10^{-9}, that is, the emitted energy was $10^9 \times$ the received energy [see also Turpain, Abstract No. 1110 (1907)]. The author thinks that for very great distances the earth connection is probably of advantage, but for closely tuned spark telegraphy up to, say, 300 miles its absence is desirable. L. H. W.

1104. *Magnetic Detectors.* **C. Maurain and C. Tissot.** (Rev. Électrique, 8. p. 68, Aug. 15, 1907. Paper read before the Assoc. franç. pour l'avancement des Sciences, at Rheims.)—The authors discuss the difficulty which exists in obtaining experimentally an insight into the separate effects which go to make up the observed net effect obtained when electric oscillations act upon a

magnetic detector. Oscillations obtained by the arc method should, owing to their constant amplitude, render the investigation more easy. Those detectors which utilise the action of the oscillations on the energy lost in hysteresis [Walter-Ewing type], as opposed to those in which the instantaneous change of induction [Marconi type] is observed, are considered to lend themselves better to the recording of signals. Such detectors do not appear to have been sufficiently utilised; in conjunction with "continuous" oscillations, a very strong effect should be obtained owing to their integrating action. Further quantitative experiments with detectors of this type are desirable. L. H. W.

1105. *The Steljes Relay.* (Elect. Rev. 61. p. 6, July 5, 1907.)—This relay, devised and patented by E. W. Steljes, consists of an arrangement which has for its object the provision of independently pivoted polarised tongues in combination with a single core, whereby three or more circuits can be opened and closed under the control of a main controlling circuit, or three or more other devices or sets of mechanism can be operated under the

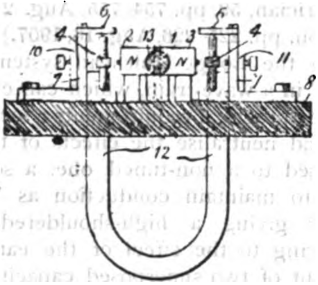


FIG. 1.

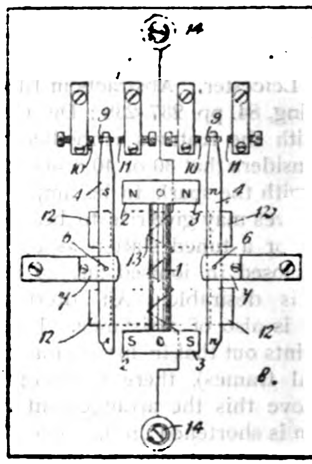


FIG. 2.

control of a main or controlling circuit. In the arrangement shown by Figs. 1 and 2, 1 is the core of an electromagnet, each end of which is made T-shape, so that it has two oppositely arranged polar projections 2, 3 at each end constituting one pair 2, 2 or 3, 3 of lateral polar projections at each side of the electromagnet. Opposite each pair of lateral projections 2, 2 or 3, 3 is arranged a lever or tongue, 4, pivoted at 6 within a supporting bracket 7, mounted upon an insulated base 8, and carrying a movable contact 9 working between two fixed contacts 10, 11, so that the apparatus serves to control four circuits. The levers or tongues, 4, are permanently polarised by a pair of bent permanent magnets 12, and the mode of operation is evident from the Figs. In another arrangement a pair of tongues is caused, by means of pawls, to drive a ratchet-wheel for recording instruments, column-printing telegraph apparatus, &c. E. O. W.

1106. *The Effect recorded by the Electrolytic Detector.* C. Tissot. (Rev. Électrique, 8. pp. 69–78, Aug. 15, 1907. Paper read before the Assoc. franç. pour l'avancement des Sciences, at Rheims. Comptes Rendus, 145. pp. 226–229, July 22, 1907. Abbreviated.)—Using in place of the telephone a galvano-

meter, the author has made comparative experiments with an electrolytic detector and a bolometer. The latter was placed directly in the previously tuned antenna circuit; the electrolytic in a tuned circuit loosely coupled to the antenna circuit. Used in the ordinary way, with auxiliary polarising e.m.f. (Fessenden, Schlömilch, de Forest), the results show that when the received energy exceeds a certain amount, always extremely small, a limiting value of the deflection (decrease of resistance) is observable, something after the nature of the effect with a coherer or, one might say, of a Rutherford magnetic detector completely demagnetised. The following figures are given :—

Bolometer reading	4	25	85	140
Electrolytic „	60	75	80	80

Below this critical value the electrolytic is to some extent quantitative in its indications. The sensitiveness is greatest from 2·7 volts applied e.m.f. upwards, but a compromise has to be effected owing to the noise caused by the gassing at such a high voltage. When the electrolytic is used without any external e.m.f. [as Ferrié first employed it, Abstract No. 1775A (1905)] the readings are strictly quantitative; the galvanometer is normally at zero, takes up a fixed deflection while oscillations are acting, and returns exactly to zero on the oscillations ceasing. The following figures show that the proportionality holds all through :—

Bolometer reading	60	40	20	15	5
Electrolytic „	89	26·5	13·5	10	8·5

From these results one can infer that the direct current through the detector (when no auxiliary e.m.f.) is proportional to the square of the amplitude of the current oscillations in the receiving antenna. L. H. W.

1107. *Production of Continuous Oscillations.* (Brit. Pat. 5,164 of 1907. Engineer, 104. p. 74, July 19, 1907. Abstract.)—H. Manders finds that the atmosphere of hydrogen or some hydrocarbon as used by Poulson can be dispensed with, provided that the electrodes be composed of certain conducting materials, which are different for the anode and the kathode; the latter should be of a material of lower atomic weight than that serving as anode. For the kathode aluminium or romanium (an alloy of Al) gives the best results; for the anode, either Zn, Ag, Co, Ni, Cu, or Fe is used, the efficiency being in the order given. It is proposed to use the inductance coil (choking coil) in the supply circuit as an electromagnet for the purpose of providing the magnetic field round the arc [although Eisenstein has shown that this is detrimental to the production of steady oscillations, see next Abstract]. L. H. W.

1108. *Experiments with Undamped Oscillations.* **S. Eisenstein.** (Elektrotechn. Zeitschr. 28. pp. 880–883, Aug. 22, 1907.)—The author gives a somewhat belated account of experiments initiated in 1904, on the arc method of producing oscillations; his theoretical considerations should be referred to in the original. Among the more interesting practical points, he tried at first to use the choking coils for the purpose of producing an arc-extinguishing magnetic field, but the result was to cause the arc to constantly wander about, while the frequency also was variable. Poulsen's steady magnetic field was therefore reverted to; it was, however, found better to employ loose coupling instead of the close coupling advocated by Poulsen. Experiments with

compressed gases as the arc-surrounding medium are briefly indicated. For wireless telephony an arrangement based upon the magnetising effect of the microphonic current when passed through the field-coils of the dynamo supplying current to the arc is described, after the manner of S. G. Brown's device. It was found better to employ the demagnetising effect as being more rapid; it also gave better reproduction of speech. The arrangement can also be used for wireless telegraphy, by including an interrupter (ticker). The experiments are now being carried out at a large-size station between Kieff and Schmerinka (South Russia); 280 km., over hilly ground. L. H. W.

1109. *Arc and Spark in Radio-telegraphy.* **W. Duddell.** (Elect. Engineering, 2 pp. 214–216, Aug 8, 1907. Elect. Engin. 40. pp. 194–197, Aug. 9, 1907. Nature, 76. pp. 426–430, Aug. 22, 1907. Discourse delivered before the British Assoc. at Leicester.)—Reviews the methods available for producing oscillations. The author considers the arc method particularly well adapted for very high speed signalling, in that even at 300 or 400 words per min. the dot will last long enough to include many hundreds of oscillations—more than sufficient to allow of good tuning. The drawback, in the case of the spark method, that the dot must at least occupy the average time required to charge the condenser and produce one spark (as a minimum), is a serious one at higher speeds. No difficulty is anticipated by the author as regards intercommunication between the arc and spark systems, provided that the spark telegraph stations send out wave-trains persisting for a sufficient number of oscillations. Wireless telephony is briefly referred to.

L. H. W.

1110. *Sustained Oscillations and Syntonic Wireless Telegraphy.* **A. Turpain.** (Rev. Électrique, 7. pp. 357–369, June 30, 1907.)—The author briefly reviews the methods (electrical and mechanical) which have been proposed for obtaining syntonic working; the arc method is then more fully considered. Summing up, he points out that, from the fact that Marconi employed 100 h.p. to affect a receiver 5,000 km. distant, capable of responding to 400 microergs, the efficiency may roughly be taken as $0{\cdot}5\times10^{-15}$ [compare, however, Lodge, Abstract No. 1108 (1907)]. This low efficiency is used as a basis for urging the adoption of the author's previously suggested method in which Hertzian waves [oscillations] are used *with* conducting wires.

L. H. W.

1111. *Measurements with Subdivided Spark-gaps for Wireless Telegraphy.* **W. Eickhoff.** (Phys. Zeitschr. 8. pp. 497–498, Aug. 1, 1907. Physikal Inst. d. techn. Hochschule, Braunschweig, May 10, 1907. Écl. Électr. 52. pp. 388–389, Sept. 14, 1907.)—The subdivided spark-gap—the advantages resulting from the employment of which have been insisted upon by Braun—has been found to serve the desired purpose when small oscillator capacities are concerned and high initial sparking voltages are needed (simple Marconi excitation). When, on the other hand, the oscillator circuit is of large capacity and the initial sparking voltage is smaller, no advantage generally results from subdivision of the gap. The author has investigated the limits within which subdivision of the gap is advantageous, using the Bjerknes resonance method. Curves plotted between sparking distance and decrement are reproduced, for capacities of 8,000, 1,150, and 565 cm. and spark-lengths up to 22 mm. (in last case up to 45 mm.); (1) with single gap, (2) with gap in two parts, (3) with gap in five parts. Within the

range of spark-length examined, the single (simple) spark-gap is in all cases *superior* to the subdivided gap; the damping is practically only half as great for the shorter spark-lengths. The case where small capacities (150 cm.) are put in parallel to each separate gap of the multiple gap does, it is true, show a very slightly reduced damping (by 4–5 per cent. only). L. H. W.

1112. *Capacity in Telephony.* **R. Salvadori.** (Elettricità, Milan, 29. pp. 86–91, Aug. 9, 1907.)—The author points out the immense importance of capacity in all small-current work, particularly where the currents are of high frequency. The enormous loss of current due to the capacity between a long line wire and the earth is shown by calculation. It is also pointed out that a capacity acts as if it were a conductor whose conductance increases with the frequency, hence the attenuation is greater with high frequencies; and since the characters of the sounds of speech depend on the higher harmonics, the result is distortion. As compensation for these difficulties introduced by capacity, we find that a condenser is a true filter for alternating currents. Thus a small capacity offers an obstruction to alternating currents of low frequency but permits those of higher frequency to pass without difficulty. A condenser of moderate capacity in a telephone line will cut off all disturbances due to power circuits having a frequency of, say, 25 per sec., while not interfering at all with the telephonic currents. By placing a condenser in parallel with another branch circuit having a condenser and large inductance, we may separate the telephonic current from the disturbing currents of low frequency, since the latter will pass through the branch having inductance, while the former will pass only through the branch having capacity alone. A third branch having only inductance would filter out the continuous current as well. In exchanges where the central battery system is used condensers should be provided to form a by-pass, so that the alternating currents of speech do not require to pass through the battery. The author then goes into the various types of condenser, discussing more particularly the theory of electrolytic condensers. J. E.-M.

1113. *New Automatic Telephone Exchange.* **R. C. Butler.** (Elect. Engineering, 2. pp. 110–112, July 18, 1907. From "Telephony," Chicago.)—This is equipped by the American Automatic Telephone Co. and installed at Ironton, Ohio, for the Home Telephone Co. The system of numbering is different from any other system, and is known as the "hyphenated" number system, either single or double numbers being transmitted. The switches necessary to an exchange in which two motions of the dial are used to complete a call, are known as distributor B, C, D, X, and G switches. When a subscriber removes the receiver from the hook, the talking circuit is closed through the spring of the substation selector or calling device. This operation energises the line relay, which removes the ground battery from the contact representing the calling subscriber on a row of semicircular bank contacts. Above this "busy" row of contacts and swept by wipers mounted on the same shaft, are the corresponding rows of "line" and "mate" contacts. Thus on the banks of a B switch there are three rows of 50 contacts representing the "line," "mate," and "busy" of fifty subscribers' lines. On the instant that the line relay acts, a distributor switch is started by the forward contact on the line relay springs. This distributor switch in its rotation throws ground on a bank point representing the starter wire of a B switch in the group from which the call is to be made, starting it to sweep its arc of bank contacts. As soon as the wipers have travelled to the point from which the ground has

been removed on the "busy" row of contacts, the calling subscriber's line has been found and, having found the caller, it stops, returning ground battery to the point from which the line relay had removed it. In stopping, the B switch also throws ground on a corresponding point in a fourth row of contacts on the banks of the B switch. This last-mentioned ground contact operates the cut-off relay. On the same instant that the B switch leaves its normal position in its search for the calling line, the X switch starts to rotate in search of an idle C switch. The B and X switches being in series, then, the subscriber is now connected direct to the line jacks on the C switch, which may call into any one of fifty groups, each group representing fifty subscribers. The above operations are all accomplished in from 1 to 1½ sec. The group to be reached is designated by the first number called on the dial at the calling subscriber's station. The calling device, or substation selector, has only two springs. These, with the receiver hook springs of the common battery variety, are the only springs in the subscriber's station. The springs in the substation selector are normally closed, and are so arranged that the contact is opened and the circuit interrupted when the dial is operated. These interruptions always correspond to the number pulled on the dial, which may be from 1 to 50. Thus, if 35 be pulled on the dial, the impulses occasioned by opening the circuit 35 times would be taken up by the mechanism and magnets of the C switch, causing it to rotate to the 35th point on the bank contact arc. This 35th point, then, represents a junction line to the 35th group of fifty subscribers. All the trunks to this group are terminated on the banks of the D switches for this group, and these D switches find the calling junction in practically the same manner as the B switch found the subscriber's line. Then comes the simple operation of calling 21 on the dial, and connection is made with the substation 35-21 through the G switch, which is the last to rotate. This G switch is equipped with a greater number of relays, and has a more complex circuit for purposes of ringing the called subscribers' bells, detecting busy lines, &c. When a subscriber has finished talking, he hangs up his receiver, which makes his line test open. This permits certain relays on the switches to make back contacts, which operate to release the call, and restore the switches to normal. On party lines in this system the group of fifty subscribers is in reality four groups, on the banks of which are represented fifty line circuits. A certain number (any that is desired) of G switches is supplied with 16-cycle harmonic ringing current, then for each of 33-, 50-, and 66-cycle ringing current the same number of G switches are installed. To the banks of all these G switches all the 50-line circuits are multiplied straight through, so that the initial number of the call to any one of these party line subscribers merely indicates which ringing current is desired on any one of these fifty lines. When a busy telephone is called, an audible busy test is transmitted to the subscriber. The system uses two wires only to each subscriber's instrument, and at Ironton the system is provided with Dean harmonic party lines. Hanging the receiver on its hook opens the circuit, releases the switches and restores them to normal. E. O. W.

REFERENCE.

1114. *Magnetite Detector of Electric Oscillations.* (U.S. Pat. 854,813. Electrical World, 50. p. 314, Aug. 17, 1907. Abstract.)—Besides carborundum [see Abstract No. 1789A (1906)], H. H. C. Dunwoody finds that magnetic iron oxide crystals (natural or artificial) or loadstone can be employed as a detector. L. H. W.

SCIENCE ABSTRACTS.

Section B.—ELECTRICAL ENGINEERING.

OCTOBER 1907.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

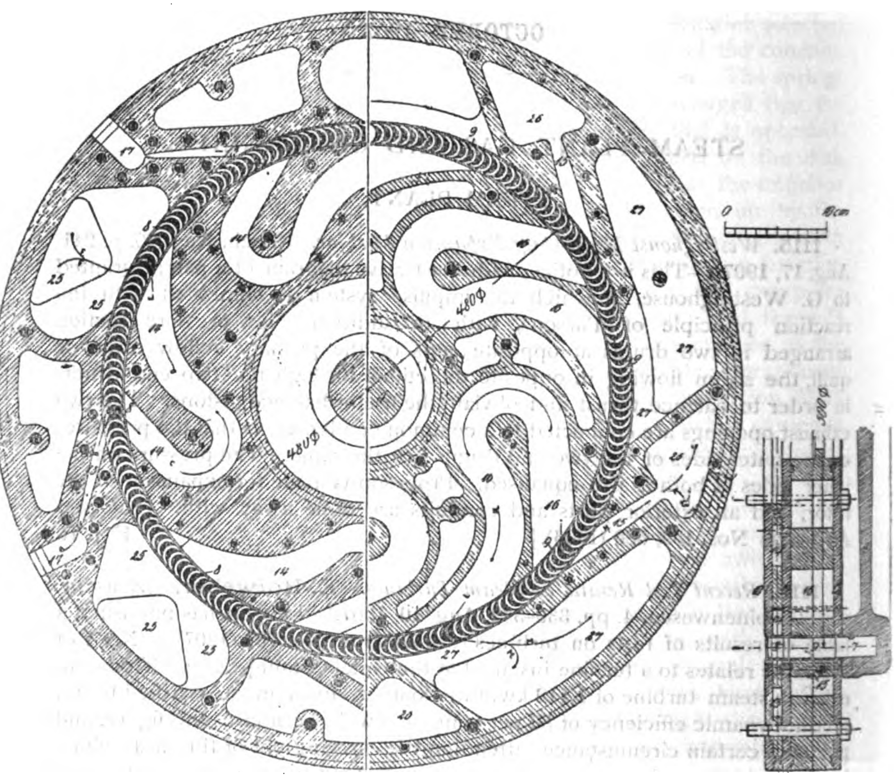
1115. *Westinghouse Multi-stage Expansion Turbine.* (Mech. Eng. 20. p. 241, Aug. 17, 1907.)—This is a notice, with illustrative diagram, of a patent granted to G. Westinghouse, in which the impulse system is combined with the reaction principle of Parsons, with an additional low-pressure section arranged in two drums at opposite ends of the primary hollow drum or quill, the steam flowing in opposite directions through the two end drums in order to balance thrust and obviate the use of balance pistons. The two exhaust openings are connected to a common condenser, so that the pressures on the outer sides of the two end drums are the same. The pressure on the inner sides of both is also equalised. Provision is made for expansion of the rotor, and all exterior ports and conduits are done away with. [See also Abstracts Nos. 189, 686 (1906).] F. J. R.

1116. *Recent Test Results on Steam Turbines.* E. Hofweber. (Zeitschr. ges. Turbinenwesen, 4. pp. 380–382, Aug. 10, 1907.)—Langen has published a table of results of tests on turbines [see Abstract No. 781 (1907)]. No. 7 of this table relates to a turbine installed at the Gutehoffnungshütte. This is an exhaust steam turbine of 1,112 kw. rated output, and Langen ascribed to it a thermodynamic efficiency of 80 per cent. Hofweber criticises this figure, and points to certain circumstances attending the carrying out of this test, which he thinks obscure the results. In the main Hofweber's remarks are directed toward indicating that no such thermodynamic efficiency as 80 per cent. could properly be ascribed to the turbine in question. In reply to Hofweber this contention is practically admitted by Langen, and the reasons for his inadvertent misinterpretation of the results are indicated. H. M. H.

1117. *Saving Exhaust Steam from Intermittently-running Engine.* (Power, 27. pp. 600–601, Sept., 1907.)—In order to utilise the heat of the exhaust steam from the engine of a large steel rolling-mill, the Harrison Safety Boiler Works installed a feed-heater, which is illustrated, by end elevation and partial longitudinal section. The admission of cold water is made simultaneous with the admission of exhaust steam by a lever worked from the starting platform (or

"pulpit"), which controls both engine valve-gear and water-admission valve of the heater by one movement. Should the engine stand idle for a period exceeding about 8 min., and the feed pump to boilers cause a certain fall in the water-level of the heater, a float opens the water-admission valve simultaneously with a steam valve admitting live steam to the heater, and in this way the temperature of the water in the heater is maintained, with all the advantages of a feed-heater of this type. F. J. R.

1118. *Weichelt's Steam Turbine.* (Zeitschr. ges. Turbinenwesen, 4. pp. 353–356, Aug. 20, 1907.)—A description of a steam turbine patented by C. Weichelt Two types are described. (A) Turbine with two pressure-stages, in the first



of which only, the steam admission can be regulated. There is only one turbine wheel and one ring of blades. Both high- and low-pressure nozzles and also the exhaust chambers are located on the outer periphery of the blade ring, the flow of the steam inside of the blade ring being directed by stationary canals. The steam thus passes through the blades four times before leaving the turbine. The general arrangement is shown in the two transverse sections are given in the accompanying Figs. relating to 60-h.p. 3,000 r.p.m. design. The longitudinal sections showing the general arrangement are on too small a scale for reproduction. The flow of the steam is as follows: High-pressure admission 18, blades 8, canal 14, blades 8, intermediate chambers 25 and 26; low-pressure admission 15, blades 9, canal

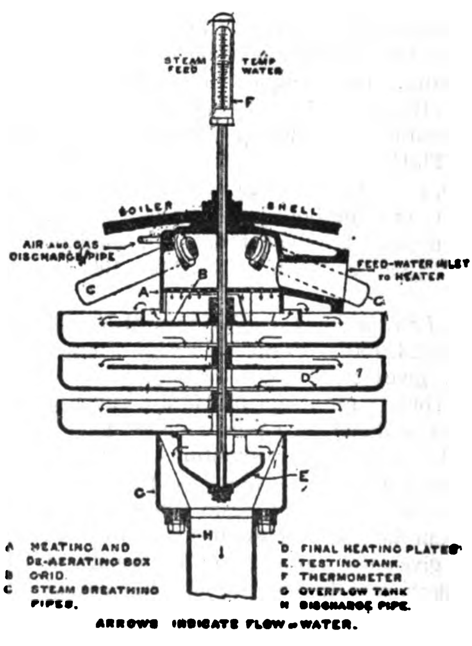
16, blades 9, exhaust 27. A 60-h.p. 3,000 r.p.m. turbine of this type, with slightly superheated steam at 11 atmos. pressure and with condenser and a good vacuum, had a steam consumption of 8·5 to 9 kg. steam per h.p.-hour. Turbines of this type can be constructed for 5 to 200 h.p. at from 8,000 to 1,500 r.p.m. (B) Turbine with two pressure-stages, in both of which the steam admission can be regulated. This type has two wheels of different diameters, each with a separate blade ring. The flow of steam is directed by canals inside of the blade ring, as in type (A), but the steam only passes twice through each blade ring. A 500-h.p. 3,000 r.p.m. turbine of this type, with slightly superheated steam and with condenser and good vacuum, had a steam consumption of 5·5 kg. steam per h.p.-hour. The velocity of the blades in this type varies between 50 and 140 m. per sec. For outputs of 20 to 500 h.p. the speed is 3,000 r.p.m., and for larger outputs of 600 to 1,000 h.p. only 1,500 r.p.m. H. M. H.

1119. *Relative Economy of Steam and Gas Power where Exhaust Steam is used for Heating.* **F. W. Ballard.** (Eng. News, 58, pp. 158–159, Aug. 15, 1907. Paper read before the Ohio Soc. of Mechanical, Electrical, and Steam Engineers.)—After comparing the heat expenditure and fuel costs of gas and steam engines, the author deals with the amount of steam (exhaust and live steam) required for heating operations. In practice, 1 lb. of exhaust steam supplies about 8 sq. ft. of radiation. If steam engines use 30 lbs. steam per h.p.-hour then 1 h.p. would furnish enough steam to heat 450 sq. ft. of offices or 600 sq. ft. of factory space, or 900 sq. ft. of warehouses. The cost of fuel is then estimated on the assumption of an evaporation of 8 lbs. per 1 lb. of fuel at American rates. In a simple non-condensing engine using 30 lbs. steam per h.p.-hour, there are about 30,000 B.Th.U. contained in the exhaust steam, capable of heating about 90 sq. ft. of radiation. The author assumes only about 6,000 B.Th.U. per h.p.-hour as available in the exhaust gases from a gas engine, which, if used for heating, would serve about 20 sq. ft. of radiation. The possibility of using both jacket water and exhaust gases in tubular boiler heaters is mentioned, but the author is not sanguine of any great extension of this system. [See also Abstract No. 1490 (1905).] F. J. R.

1120. *Superheated Steam for Steam Turbines.* **J. A. Moyer.** (Mech. Eng. 20. pp. 276–278, Aug. 24, 1907. From "Harvard Engineering Journ.," June, 1907.)—The author gives curves of water rate or steam consumption for a 5,000-kw. Curtis turbine with steam of 175 lbs. gauge pressure, at different degrees of superheat, and one for a Westinghouse-Parsons turbine of 400 kw. with steam of 150 lbs. under similar conditions, and for comparison theoretical curves for approximately the same limits as in these cases. In this diagram one line represents the theoretical steam consumption calculated from the energy available from the adiabatic expansion of 1 lb. of steam, using 0·48 for C_p. Another line gives the curve using the values of C_p ascertained by Knoblauch and Jakob, and Lorenz, which gives considerably lower values for water rates. Another diagram gives the economy of steam due to superheat on a percentage basis. The gain in steam economy is shown to be due in part to (1) economy of the energy in the steam, and (2) superior mechanical operation. A diagram shows the percentage reduction of rotation loss in superheated steam. A combination of impulse and reaction types is recommended for the best results. Regarding the specific heat of superheated steam, the author believes Lorenz's results to be the best [Abstracts Nos. 2451 (1904), 874 (1905)], and he adds an investigation of the subject by an indirect

method, viz., finding first a simple law for the change of flow of superheated steam with varying degrees of superheat, and then applying this law to the well-known equations for the velocity and flow of dry saturated steam. From observations by Lewicki, Rosenhain, and others, along with his own, the author gives the following formula for the flow of superheated steam: $W = W_1(1 + aD)$, when W is the flow of dry saturated steam through an orifice or nozzle, W_1 is the corresponding flow of superheated steam for D degrees of superheat, and the coefficient a is 0·00065 for Fahrenheit degrees and 0·00117 for Centigrade degrees. It has been found that this formula is accurate to ½ per cent. from saturation temperature to 500° F. superheat. Zeuner's equations for velocity and flow for either dry, saturated, or superheated steam are quoted and applied to show that the impulse force does not vary with the degrees of superheat when the temperature change is small; and in the following calculations for impulse force the author uses a simplification of these equations known as Grashof's law. Formulæ are also given for the available energy of superheated steam and for the total heat in 1 lb. superheated steam, the latter to be used with the curves given in the diagrams. F. J. R.

1121. *Wilkinson Feed-water Heater.* (Elect. Engin. 40. pp. 272–274, Aug. 28, 1907. Elect. Engineering, 2. pp. 801–802, Aug. 22, 1907.)—Refers to previous papers on live-steam feed-heating [see Abstracts Nos. 1006 (1906),



5 and 240 (1907)], and describes with two illustrations [one of these printed upside down] Wilkinson's feed-heater, which is placed in the steam space of the boiler. The accompanying section and reference lettering fully describe this apparatus. The discharge pipe H is carried to the bottom of the boiler inside, and the air discharge pipe to a valve outside the boiler. The thermo-

meter gives the temperature of the feed-water at the point where it flows into the pipe H. The following figures give the results of tests made upon a boiler which had been continuously under steam for four months prior to April 24, 1907, when the tests were made :—

	Economiser with Heater.	Economiser without Heater.	Difference in favour of Heater.
Duration of test	8 hours	8 hours	—
Coal burnt per hour	888 lbs.	844 lbs.	—
Coal per hour per sq. ft. of grate	26·1 lbs.	24·82 lbs.	—
Water evaporated per hour	8,824 lbs.	7,425 lbs.	—
Water per hour per sq. ft. of heating surface	8·02 lbs.	6·75 lbs.	1·27 lbs.
Water evaporated per lb. of coal	9·93 lbs.	8·79 lbs.	1·14 lbs.
Equivalent evaporation from and at 212° F.	12 lbs.	10·64 lbs.	1·36 lbs.
Absolute steam pressure (average)	155·9lbs.	155·8 lbs.	—
Steam temperature by thermometer	363° F.	364° F.	—
Feed temperature from economiser	256° F.	246° F.	—
Feed temperature due to steam feed-heater	363° F.	—	—
Combined efficiency of plant, including superheater	84·58 %	74·78 %	10·4 %
Calorific value of coal (B.Th.U.)	14,200	14,200	—

Summarised, the substantial gains are as follows: Increased evaporation per lb. of coal, 12·9 per cent.; saving in coal, making no extra allowance for a continuously clean and efficient boiler, 11·4 per cent.

F. J. R.

1122. *Comparative Costs of Gasoline, Gas, Steam, and Electricity for Small Powers.* **W. O. Webber.** (Eng. News, 58. p. 159, Aug. 15, 1907.)—This paper consists of a series of tables in which the costs of power on the various systems are stated in full, including all fixed charges, and worked out per annum for the different sizes of plant, and then reduced to 1 h.p. per annum on a 10-hour day basis. The following is an abstract of the tables :—

Cost of 1 H.P. per Hour, in Dollars.

	Size of Plant in H.P.			
	2	6	10	20
Gasoline at 20 cents per gall	0·1352	0·0780	0·0492	0·0331
Electricity at 13½ cents per kw.-hour, with discounts	0·0928	0·0558	0·0497	0·0417
Gas of 700 B.Th.U. per cub. ft., at $1.20 per 1,000 cub. ft.	0·1014	0·0581	0·0456	0·0367
Steam coal at $5 per ton	—	0·0906	0·0832	0·0475

A fifth table gives annual cost of power per b.h.p.-hour on the four systems from 1 up to 100 b.h.p., these figures being taken from curves plotted from the first four tables.

F. J. R.

1123. *Utilisation of Sewage Mud for Motive-power Purposes.* **R. Frank.** (Gesundheits-Ingenieur, München, July 18, 1907. Elektrotechnik u. Maschinenbau, 25. p. 607, Aug. 4, 1907.)—The author describes a plant designed and erected by the Gasmotorenfabrik Deutz for the utilisation of sewage mud. The plant consists of a gas-producer, a condenser, a gas-holder, and a gas-engine. The producer is used for drying and converting the mud into gas, and is provided with a hopper for charging, two cleaning towers, and with a small electric motor for creating the blast. The condenser contains a filter cloth for retaining solid particles blown out of the producer, a water-seal (through which all the gas passes), and a scrubber. The heat value of the cleaned and scrubbed gas is from 800 to 1,000 kg.-cals., and the gas-engine designed for use with this poor-gas must be specially built for the purpose. The financial results of this plan for disposing of surface sewage mud are stated to be good, since only from 10 to 15 per cent. of the generated energy is required to drive the pumps, &c., connected with the working of the plant, and the balance of from 85 to 90 per cent. is available for other purposes. The following figures are given: A town dealing daily with 4,000 cub. m. of drainage water will produce about 12,000 kg. of mud. If this be utilised in a plant similar to that described, it will yield in the form of electric energy 4,000 kw.-hours, or 1,460,000 kw.-hours per year. Of this total 85 per cent., or 1,240,000 kw.-hours, will be available for general use. A 70-h.p. gas-engine has been worked continuously for some months on this type of gas at Deutz. J. B. C. K.

1124. *Efficiency of Feed-water Heaters.* **P. Fuchs.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1106–1109, July 13, 1907.)—A series of ten experiments for the purpose of determining the efficiency of a feed-water heater. Experiments were made with various ratios of boiler surface to feed-water heater surface, the ratio varying from 1 to 2·5. Various fuels were used, and in each case the gases were carefully analysed. The amount of water per hour per sq. m. of surface was also varied from 17 to 39 kg. The amount of heat given up to the feed-water per hour per sq. m. of surface per 1° C. difference between gas temperature and water temperature, was found to vary from 10 to 14 kg.-cals. The efficiency of the feed-water heater worked out at 86 per cent. in one case. H. M. H.

1125. *Tests of Isolating Valves for Steam Pipes.* **G. W. Koehler.** (Engineering, 84. pp. 71–72, July 19, 1907. Abstract from Mitteilungen über Forschungsarbeiten des Vereines Deutsch. Ing., No. 34.)—Systematic experiments were made in the Technical High School of Karlsruhe on eleven types of isolating valves, all German and Austrian. The valves were all 70 mm. (2¾ in.) diam., fitted into a pipe of 15 m. (50 ft.) length from the boiler. A valve with lever weighted with 20 kg. was employed to produce fracture effects. Closing and counter-forces were altered with steam both flowing and at rest. Boiler pressure was varied between 3 and 8 atmos., and the areas of artificial fractures were also altered. The general conclusion is in favour of valves normally held open by their own weight or combined with an adjustable lever. In some cases—as on board ship—spring devices are necessary. Where the steam pressure is the counter-force, the reliability of action is often affected by fluctuations in the boiler pressure, or in the density of the steam. Valves which depend upon intermediate mechanisms are not very reliable, and pistons and stuffing-boxes, or similar parts which impede action are undesirable. Every boiler which has more than 40 sq. m. (430 sq. ft.)

heating surface, or which works with steam of more than 5 atmos. should be provided with an isolating valve of simple construction, capable of rapid opening by hand (in the case of premature action only), combined with a balanced valve, in order to oblige stokers to fill the steam-pipe system slowly, which valves should be duly tested. F. J. R.

1126. *Capacity of Cooling Towers.* **C. O. Schmitt.** (Engineer, 104. pp. 268–270, Sept. 18, 1907. Paper read before the South African Assoc. of Engineers, April 10, 1907.)—The average loss by evaporation alone from a storage dam in the Transvaal has been found by test to be 5 ft. per annum, apart from the necessary evaporation to obtain the desired cooling of the circulation water; and the installation of cooling towers is practically a necessity in all but coast towns in South Africa. This paper gives the results of tests of four types of towers, of which illustrations are given: (1) Open type of tower filled with brushwood. (2) Same type, but with brushwood replaced by inclined sheets of corrugated iron, with the corrugations running across the tower so that small pockets are formed, and the water runs as a thin layer between the corrugations. (3) Two towers of the Klein enclosed type, with natural draught by means of a chimney 45 ft. above top of water tank. (4) A combination of the brushwood and the Klein types. The readings obtained in the various tests are shown in a series of five tables, which are too voluminous for abstracting, and the capital costs are grouped in a sixth table. Maintenance costs were found to be negligible for all types of towers. Power consumed was measured by the quantity of water lifted from the water-level in the pond to the distributing launder, the total efficiency of pumping plant being taken at 50 per cent., and the cost of the power at 1d. per b.h.p.-hour. Capital charges were taken at 8 per cent. interest and 12 per cent. depreciation, calculated on cost of tower and pond complete. The basis of comparison between the various towers was arrived at by taking the cost of abstracting 1,000,000 B.Th.U. from the circulating water. This was obtained by taking the actual costs per min., both of power and capital charges, and multiplying by 1,000,000/(the actual number of B.Th.U. abstracted per min.). A "coefficient of capital charges" was obtained by dividing the work done per min. (*i.e.*, B.Th.U. extracted per min.), by the capital outlay, and by dividing this coefficient by the static head of the tower a "factor of total efficiency" was obtained, this being held to offer a more satisfactory basis of comparison, because the cost of power is represented in it. A coefficient of floor space is also worked out in the tables, and curves showing the duty of the various towers, the costs, and the effects of wind on the open towers are given. F. J. R.

GAS AND OIL ENGINES.

1127. *Test of a Crossley Gas Engine.* (Engineer, 104. p. 159, Aug. 16, 1907.)—This test was carried out by J. T. Nicolson to measure the gas consumption per b.h.p.-hour and for observation of speed variation between full and light load. The gas was producer gas from a Crossley producer, calorific value calculated from analyses 156·5 B.Th.U., and by Junker's calorimeter 149 B.Th.U. per cub. ft. at the temperature and pressure of the calorimeter. The volume of gas used per hour was 29,087 cub. ft. corrected to 0° C. and 760 mm. of mercury and the b.h.p. being 559, the gas used per b.h.p.-hour at 0° C. and 29·92 in. barometer was 29087/559 = 51·94 cub. ft. The heat supplied was 51·94 × 156·5 = 8,128 B.Th.U. per b.h.p.-hour, and the thermal

efficiency of the engine was 2546/3128 = 0·8192 or 81·92 per cent. The engine varied in speed from 119·4 to 121·4 r.p.m. when the h.p. was instantaneously dropped from 600 to 50, which represents a total variation of 1⅔ per cent. of the mean speed. No back-firing took place. F. J. R.

1128. *Explosive-mixture Engines.* **A. B. Willits.** (Engineer, 104. pp. 273–274, Sept. 13, and pp. 299–300, Sept. 20, 1907. Abstract from Journ. of the Amer. Soc. of Naval Engineers.)—In the course of this paper the author describes the single-acting 6-cylinder Standard petrol engine of the Standard Motor Construction Co., of Jersey City. Engines of this type have been fitted on several ferry-boats and have given satisfactory results; they can be started and reversed by means of compressed air and a single movement of a cam-shaft lever, as with an ordinary link motion. The air is compressed into tanks at 250 lbs. per sq. in. by means of a 1-h.p. auxiliary petrol engine driving an air pump. Three of the cylinders only are operated with compressed air for reversing, while the other three always operate on petrol. The author considers that there will be no future for the single-acting engine for large powers in marine work, and he describes a 500-h.p. double-acting 4-cycle "Standard" engine from the designs of C. C. Riotte. The valves in this engine are positively operated, water-cooled, and balanced. The pistons are cooled by water circulation through the crosshead and piston-rod. With one motion of a lever the engine can be changed to a 6-cylinder single-acting motor, cutting down to half-power without sacrifice of economy. Further, each set of three cylinders can be uncoupled and used alone, thus reducing the power to ¼ the original value. As regards weight, the author gives, for a 12-b.h.p. engine, 55 lbs. per b.h.p.; for 300-h.p. engine, 40 lbs. per b.h.p., for single-acting engines. With double-acting engines this is reduced to 35 lbs. for the 300-h.p. size, and would probably be only 30 lbs. or less for a 1,000-b.h.p. engine. L. H. W.

1129. *Internal Combustion Engines.* (Engineering, 84. p. 350, Sept. 6, 1907. Abstract of Brit. Pat. 18,555 of 1906.)—In addition to the usual cylinder and valves a pump is provided, by an elongation of the engine piston of a larger diam., that compresses at each alternate stroke of the engine a suitable quantity of gas, or of gas and air, which is admitted to the cylinder through an additional admission valve after the ordinary main admission valve has closed. This gives an increased quantity of explosive mixture which is compressed in the main cylinder and adds to the power of the engine. A section of the cylinder, pump storage chamber, and valves is given. The arrangement is due to G. Westinghouse. F. J. R.

1130. *Internal Combustion Engines for Marine Purposes.* **J. T. Milton.** (Inst. Civ. Engin., Proc. 168. pp. 113–129; Discussion and Correspondence, pp. 130–168, 1906–1907.)—Discussing only the mechanism of the engine, the author states the requirements for a successful marine engine. Regarding the turning moment and the ratio of maximum to mean in different arrangements of cylinders and cranks, he concludes that three pairs of tandem cylinders and three cranks will probably give the best results as to smoothness of running. By cutting out one cylinder and reducing the charge in the remaining cylinders a considerable range of speed is obtained. He decides in favour of this class of engine with separate compressing cylinder driven independently of the main engines. In the *discussion*, **D. Clerk** enumerated some of the difficulties experienced with engines having separate compressing pumps.

F. W. Burstall emphasised the difficulty of building large vertical gas engines, and of arranging reversing gear for valve cam-shaft and starting with compressed air. He proposed a six-crank single-acting engine with 12 cylinders in tandem, and with quantity governing. **W. P. Sillince** instanced a reversible oil engine of 80 b.h.p. working on the Otto cycle with heavy oil, and one developing 180 to 200 h.p. per cylinder. **H. S. Hele-Shaw** referred to the Antoinette reversing engine of 360 h.p. with 24 cylinders. A 85-h.p. engine on the same plan could be lifted with one hand. The speed of the large engine was 1,800 r.p.m., and it weighed 1,500 lbs. plus 160 lbs. for accessories, or 4½ lbs. per h.p. Reversal was almost instantaneous. The Beardmore 500-h.p. producer-gas engine weighed 65 tons for the plant, or 280 lbs. per h.p. In the *Dreadnought* the principle of gears which reversed with a clutch had been passed as being quite satisfactory, and modern high-tensile nickel-chrome steel allowed wheels to be made which contravened all text-book rules. **H. C. Anstey** described the 80-b.h.p. reversible engine referred to by Sillince. **R. W. A. Brewer** thought the solution of the problem of fuel supply was the adoption of heavy oil—such as was left after distillation at 350° F. 80,000,000 tons of crude oil were produced from the world's oil-fields in 1906, so that the supply should be adequate. Such an outlet for the heavy oils would tend to increase the production of the lighter oil for motors. **W. White** put forward problems from the ship designer's point of view. He considered that the perfecting of the gas-producer would lie at the foundation of any great or general progress, and was satisfied that the visible supplies of residual products of petroleum distillation were unable to meet even a portion of the demands of the mercantile marine. **J. May** referred to the use of gas engines driving dynamos which operated electric motors on the propeller shafts of two boats on the Volga, and believed that this combination offered an ideal solution of all difficulties. **W. W. Tonkin** showed diagrams illustrating the weakening of charges by cam with six steps, and also a method of admitting compressed air with varied quantities of gas, with its effects on engine diagrams.

F. J. R.

1131. *Present Position of Gas and Petrol Engines.* **D. Clerk.** (Electrician, 59. pp. 674–677, Aug. 9, 1907. Paper read before the British Assoc. at Leicester. Elect. Rev. 61. pp. 209–211; Discussion, p. 211, Aug. 9, 1907. Abstract. Elect. Engin. 40. pp. 226–229; Discussion, pp. 229–230, Aug. 16, 1907.)—Reviews the subject specially in view of existing difficulties in the way of the development of the large gas-engine industry in Britain. For engines up to 200 h.p. suction producers with anthracite serve well, but the cost of anthracite handicaps engines of larger size, and illuminating coal-gas is too expensive. Some development of the bituminous coal producer is wanted. The engine difficulties arise from the conflict between strength of cylinder required to resist high pressures and thinness of cylinder and combustion-chamber walls to provide rapid heat flow. Cylinders of 51 in. diam. have been found to be too large for satisfactory working and endurance. The author refers to his own experiments and those of Callendar, Hopkinson, and others [Abstracts Nos. 904 (1906), 252, 788, and 1002 (1907)] as indicating the lines of research and experiment being followed with a view to finding better conditions of working. Reference is also made to Thorneycroft's and Milton's efforts [Abstract No. 695 (1906) and preceding Abstract] to perfect the gas engine for marine use. [See also Abstracts Nos. 1278 (1906) and 741 and 865 (1907).]

F. J. R.

1132. *Producer Gas for Power Purposes.* **J. R. Bibbins.** (Eng. Club Phil., Proc. 24. pp. 322–339; Discussion, pp. 339–341, July, 1907.)—In this paper the author compares the cost of producer gas with that of natural and manufactured gas in order to show that even in districts where a supply of these richer gases is available there is a field for producer plants. He shows graphically that in a 10-hour day's run producer gas made from coal costing $2.50 per ton costs no more for fuel than natural gas at 25 cents per 1,000 cub. ft., whilst on a 24 hours' run the advantage lies with the producer gas. Coal gas at 40 cents is much too dear in both cases. Where small-size anthracite can be had below $3.50 the producer can compete with natural gas. A test of a 25-h.p. pressure producer plant for a week's run brought out the average coal consumption per b.h.p.-hour at 1·6 lbs., but an inefficient boiler for blowing the producer brought the total coal up to 2·1 lbs. The coal unit in producer of the Norton 500-h.p. gas-power plant on a seven weeks' run was 1·88 lbs. per kw.-hour and 1·29 lbs. per b.h.p.-hour—the extra coal for banking fires on Sunday amounted to over 10 per cent. additional. Bituminous and anthracite coal producer plants are compared on the prices of American coals, and show that with an average of $2 coal the total producer house costs are 14 per cent. higher for bituminous coal, but when the price is $6.80 the advantage of the anthracite plant disappears. An ingenious pressure regulator for producers is described and illustrated, the use of which has enabled a gas-holder to be dispensed with in pressure plants. Two plans of gas-power plant arrangement are presented. [See Abstracts Nos. 249 and 495 (1907).] F. J. R.

REFERENCES.

1133. *Latest Research on the Specific Heat of Superheated Steam.* **R. H. Smith.** (Engineer, 104. pp. 180–182, Aug. 23, 1907.)—In this article the author describes the apparatus and procedure employed in the investigations of Knoblauch and Jakob [see Abstracts Nos. 124A (1906), 353, 507, 745, and also 482 (1907)], with five diagrams of curves plotted from their results. In one of these diagrams the curves are plotted to compare with those given in the author's previous paper [see Abstract No. 2110 (1904)], and reference is also made to the results of Lorenz [Abstracts Nos. 1743 and 2451 (1904), 374 (1905)]. **A. Jude** (p. 400). A correction. F. J. R.

1134. *The Ice Problem in Engineering Work in Canada.* **H. T. Barnes.** (Elect. Engineering, 2. pp. 228–230, Aug. 8, 1907. Paper read before the British Assoc. at Leicester. Engineering, 84. pp. 216–217, Aug. 9; Discussion, p. 258, Aug. 23, 1907.)—Refers to the formation of frazil ice and anchor ice [Abstract No. 548A (1906)], and discusses the means adopted to keep wheel-pits free from ice, as well as the injection of steam into wheel-cases, in water-power plants. [See also Abstract No. 486 (1907).] L. H. W.

1135. *Petrol Motor Omnibuses.* **W. W. Beaumont.** (Inst. Mech. Engin., Proc. 2. pp. 393–437; Discussion and Communications, pp. 438–492, March–May, 1907. Automotor Journ. 12. pp. 406–407, March 23; 440–442, March 30; and pp. 481–483, April 6, 1907. Engineering, 83. pp. 395–400; Discussion, pp. 365–367, March 22; 415–419, March 29, and Discussion, pp. 507–511, April 19, 1907.)—The original should be referred to for the comprehensive survey of present practice and the figures relating to cost of running. L. H. W.

1136. *First British Military Airship.* (Automotor Journ. 12. pp. 1298–1300, Sept. 14, and pp. 1474 and 1475, Oct. 19, 1907.)—A brief description of the chief features, with illustrations.

INDUSTRIAL ELECTRO-CHEMISTRY, GENERAL ELECTRICAL ENGINEERING, AND PROPERTIES AND TREATMENT OF MATERIALS.

1137. *Present State of the Iron-Nickel Accumulator.* **Jumau.** (Soc. Int. Elect., Bull. 7. pp. 379–425; Appendix by **P. Janet**, pp. 427–428, July, 1907.)—Jumau gives an account of the progress made in the theoretical and constructional directions since the former report [Abstract No. 257 (1904)]. Janet supplies information regarding the continuation of the endurance tests on the Edison cell, which had been discharged 98 times at the time of the 1906 report. The following table shows the amp.-hour capacity after a given number of discharges :—

No. of Discharge.	Capacity.	No. of Discharge.	Capacity.
98	160 amp.-hours	300	154 amp.-hours
150	160 „	350	154 „
200	154 „	386*	147 „
250	147* „ (* Winter)		(*413th discharge in all)

After the 350th discharge the cell was emptied and the deposit (8·5 gm. in weight) removed; the electrolyte was found to be carbonated, but without detriment to the capacity. After the 386th discharge it was endeavoured to raise the capacity again by the method advocated by Edison, of reversing the direction of charge (twice, 800 amp.-hours at 150 amps.), the temperature being kept at 30° C. By this means the capacity was brought up to 170 amp.-hours, but by the 490th discharge it had fallen to 145 amp.-hours. L. H. W.

1138. *Townsend Cell for Sodium Chloride Electrolysis.* **L. H. Baekeland.** (Electrochem. Ind., N.Y. 5. pp. 301–302, Aug., 1907.)—Baekeland replies to J. R. Crocker's strictures [see Abstract No. 876 (1907)], and refers to an omission of a footnote relating to a diagram in the original article. At some points the curve representing the amp.-hour efficiency goes above 100 per cent., this being explained as due to the fact that the liberated sodium metal accumulating upon the surface of the kathode plate forms a sort of alloy of iron. From time to time this accumulated metal reacts upon the liquid to form sodium hydroxide. On such occasions the stored-up material suddenly increases the yield, giving an abnormally high yield for a short period, followed by a period correspondingly low. Allusion is made to the difficulty of ascertaining the yield and adjusting a large number of cells in series, and as a result lower average yields are obtained than for cells run separately with good supervision. It is urged that the amount of salt carried by the kathode liquor can be regulated within satisfactory limits by modifying the hydrostatic pressure. Upon the subject of the corrosive action of the kathode liquor, it is pointed out that this occurs mainly when strong caustic lyes are evaporated, for which reason cast-iron finishing kettles are used instead of steel. W. P. D.

1139. *Rapid Electro-deposition Process.* (Elect. Engineering, 2. p. 267, Aug. 15, 1907.)—Recites the contents of the specification of Brit. Pat. 20,716 of 1906 issued to D. Roberts, M. Roberts, and E. Jaffray. The patentees

describe a combination of an extremely rapid, homogeneous, steady flow of the electrolyte under seal, and in intimate contact with a very large anode area, the flow being to or from the kathode area, thus giving an enormous dissolving area producing a concentration of the anions which are practically unmolested during their passage. All fouling is obviated by the constant pumping off of the evolved gases, which quickly rise to the surface of the electrolyte under the effect of the vacuum pumps, as also by the addition of extraction owing to the difference of centrifugal or centripetal inertia between the gases and electrolyte. It is asserted that tenacious metallic deposits can be obtained at current densities of 10,000 to 25,000 amps. per sq. ft. without the formation of an incandescent hydrogen envelope or undue heating. W. P. D.

1140. *Compound Electroplating with Silver and Nickel.* (U.S. Pat. 850,944. Metallurgie, 4. pp. 570–571, Aug. 22, 1907. Abstract.)—R. H. Marshall deposits Ag and Ni simultaneously from compound solutions of nickel cyanide (from precipitating sulphate with cyanide of potassium) and silver chloride or silver cyanide; 1¼ oz. of each of these salts are dissolved in 1 gallon of water. Temperature, current strength, and voltage are not stated; the anodes are silver plates. The Continental Silver Co., of Scottdale, has worked the process for some time, and the plated articles are said closely to resemble silver-plated goods. The deposition is much quicker than with pure silver. H. B.

1141. *Electrolytic Tin Refining.* **O. Steiner.** (Electrochem. Ind., N.Y. 5. pp. 809–812, Aug., 1907.)—The author describes the practical trials made with a modification of the Claus process for refining tin, by the Penpoll Tin Smelting Co. at Bootle in 1905. By this process the tin alloys are electrolysed in a 10 per cent. solution of sodium sulphide at a temperature of 90° C., with a current density of ½ amp. per sq. dm. of electrode surface, and with an e.m.f. of under 0·20 volt. Pure tin is stated to be deposited at the kathode, while the foreign metals are precipitated as sulphides, and accumulate as slimes on the anode and on the bottom of the vat. With certain modifications introduced by the author the process worked well, and the trials were only suspended after producing 100 tons of pure tin, because the increased price obtained for the electrolytic tin did not cover the cost of the refining process. The amount of impure tin placed on the market is also too small to render any refining process successful. The cost of treatment per ton of pure electrolytic tin produced is given as £8 15s., while the value of the silver and other metals recovered from the slimes amounted to £7 6s. The author states, in conclusion, that the electrolytic refining process will only pay if the raw metal for use in the vats can be obtained at a much lower price than that of pure tin. In the year 1905 the price of raw tin was from £112 to £116 per ton, as compared with £180 for the pure metal; and the margin of profit was too small to render advisable the further running of the experimental plant at Bootle. The amount of raw tin placed on the market annually is only about 1,000 tons. J. B. C. K.

1142. *Electrolytic-refining Methods for Bismuth.* **A. Mohn.** (Electrochem. Ind., N.Y. 5. pp. 814–815, Aug., 1907.)—The author gives details of practical trials made in bismuth refining, the raw material being a Mexican lead-bismuth bullion containing 81 per cent. Pb and 14·5 per cent. Bi. The process used was a combination of electrolytic and metallurgical processes,

the different stages being as follows: (1) Electrolytic refining and recovery of the lead by the Betts process; (2) purification of the slimes; (3) electrolytic refining and recovery of the bismuth; (4) electrolytic refining and recovery of the silver and gold. The first stage consists in the electrolysis of the bullion using a 6 per cent. solution of lead in fluosilicic acid, as electrolyte. The lead deposited upon the thin cast kathodes is quite pure, and contains only 0·01 per cent. Bi. The slimes contain 84 per cent., and are washed and then fused with caustic soda and soda ash to remove As, Sb, and Pb. The anodes for stage 3 of the process are cast from this raw material which contains 94 per cent. Bi with 2·2 per cent. Pb and 3·1 per cent. Ag. The cells used for the deposition of the Bi contain anode boxes with lattice bottoms and perforated side walls. They are suspended in pairs across the electrolysing cell, and are lined with filter cloth. A small wooden frame supports the anode rod and plate. The rod is cast with a copper pin in its head, for making connection to the cable conveying the current. Acheson graphite plates are used as kathodes, and are placed directly on the bottom of the cell. It is found unnecessary to provide a special joint between the kathode plates, since in time the deposited Bi fills in the crevices, and thus forms a joint. The electrolyte used is a solution of bismuth chloride containing free hydrochloric acid; it should contain 7 per cent. Bi with 9 per cent. free HCl. The current density employed is 20 amps. per sq. ft. at the kathode, and three times this amount at the anode. The e.m.f. at the terminals of the cell is 1·2 volts. The Bi is deposited in the crystalline form, and when the anode boxes are removed it can be gathered from the floor of the cell with a wooden ladle. It is important to maintain the concentration of the electrolyte constant; this is accomplished by adding bismuth chloride or free HCl from time to time. The deposit becomes black and spongy if the amount of Bi in solution falls below the limit named, while bismuth oxychloride is formed, and the e.m.f. of the cell rises rapidly, when too little free acid is present. The Bi obtained is washed with hot water; it is then melted in plumbago crucibles and the slag is skimmed off. Should the colour and appearance of the molten metal show the presence of impurities, caustic soda and sodium nitrate are added, and by this treatment all traces of Pb, As, and Sb are removed. A metal testing 99·8 per cent., the chief impurity of which is silver, is finally obtained. J. B. C. K.

1143. *Electrolytic Refining.* (U.S. Pat. 857,378. Electrochem. Ind., N.Y. 5. p. 327, Aug., 1907. Abstract.)—The object of this invention is to provide a means for maintaining a constant current-density between each pair of electrodes in electrolytic-refining vats, this being found to vary considerably between the electrodes in different vats, according to the rapidity with which the anode surface is eaten away. The ordinary method of removing the electrodes before all the copper or other metal is dissolved, leads to the formation of much scrap, and therefore to waste. A. G. Betts's plan is to use shunts, each provided with a switch, so as to allow a portion of the current to be switched round the tank or tanks of which the anodic area is much reduced. When the tank is first charged the shunts are open and all the current passes through the electrolyte. When the anode area becomes slightly reduced, one shunt is placed in the circuit, and the number is increased as the anode area becomes more and more restricted. In lead refining this plan offers the further advantage that it prevents the solution of copper and other impurities in the electrolyte, which would occur if the current density were allowed to increase towards the end of the refining operation. J. B. C. K.

1144. *Electrolytic Production of Sodium Oxide.* (U.S. Pat. 859,481. Electrochem. Ind., N.Y. 5. p. 325, Aug., 1907. Abstract.)—As now prepared, the oxides of sodium are made by the oxidation of metallic sodium. The object of the invention is the production of these oxides in one operation by the electrolysis of fused sodium chloride. The cell designed by C. F. Carrier, Jr., for this purpose, comprises closed anode and kathode compartments, connected below by a seal of fused lead. The electrolyte in the anode compartment is fused sodium chloride, in the kathode compartment fused sodium hydroxide mixed with some oxidising agent, as, for example, sodium nitrate. The cell is maintained at a temperature over 850° C. by means of burners placed below it, and a mechanical arrangement is employed in order to obtain circulation of the molten lead intermediate electrode along the bottom of the cell. The electrolytic decomposition of the fused chloride produces, in the anode compartment, free chlorine gas, and in the kathode compartment Na_2O or Na_2O_2, according to the conditions prevailing at the time of the transfer of the sodium ions to this compartment of the cell. The anodes used for the cell are made of Acheson graphite, and the kathodes of nickel or iron. The mixed oxides obtained from the kathode compartment are heated in an atmosphere free from moisture and CO_2 gas, in order to convert the Na_2O into the higher oxide Na_2O_2. Sodium nitrate must be added from time to time to the kathode compartment of the cell. [See also Abstract No 888 (1907).] J. B. C. K.

1145. *Electrical Production of Pig-Iron and Steel.* **B. Neumann.** (Stahl u. Eisen, 27. pp. 1256–1263, Aug. 28, 1907.)—The author comments upon Haanel's report on the experiments of the Canadian Commission with Héroult furnaces, and illustrates some more recent types of such furnaces. Turnbull and Wolff, of Welland, Ontario, have constructed a 3,000-h.p. furnace for an output of 35 or 40 tons of pig per 24 hours. Another Héroult furnace is of oval section, and divided by a central vertical partition, so that the furnace shaft forms a U, which is lined with bricks of magnesia and quartz. A Turnbull furnace is trough-shaped and provided with six vertically suspended electrodes, and a central feeding shaft. The new induction steel-furnaces of Grönwall, Lindblad, and Stålhane have been taken up by the Electrometal Co., of Ludvika, in Sweden. The phase-lag of induction furnaces can, according to Lindblad, be diminished by reducing the current frequency to 15, and even to 8 or 5 periods—which is technically objectionable—or by increasing the resistance of the secondary circuit (the metallic bath) and by increasing the magnetic reluctance of the two stray fields. For these latter purposes he proposes to melt the iron in a "bifilar" trough, which follows the outlines of a U in a closed curve. In the modified "contact" furnace he separates two parallel troughs by a dyke of fire-brick. H. B.

1146. *Making (Iron) Articles by Electroplating.* (U.S. Pat. 850,912. Metallurgie, 4. pp. 571–572, Aug. 22, 1907. Abstract.)—T. A. Edison makes cylindrical containers of iron for accumulators in the following way, with the aid of three tanks. The mould is a brass cylinder which can be turned about its vertical axis. It is first dipped into fused paraffin and covered with graphite, and then lightly coppered (0·04 in. thick) in an acid copper bath, and nickeled (0·001 in.). The iron bath contains up to 15 per cent. of ferro-ammonium sulphate, free of ferric salt and of acid. Currents of 1 or 1·2 amp./dm.^{2} act for 80 or 85 hours at 40° C. to produce an iron deposit of 0·02 in. The kathode mould is rotated at 90 r.p.m., and further to prevent pitting by gas-bubbles,

about half as much charcoal as the bulk of liquid is added to the solution. About 0·4 per cent. of carbon is taken up from this charcoal. Mould and deposit are then separated in hot water, the copper is dissolved out by means of copper nitrate or sodium nitrate, and the iron, together with the film of nickel, is heated in a hydrogen atmosphere, when the hitherto brittle iron becomes tough and is converted into steel, owing to its content of carbon.

H. B.

1147. *Electric Smelting in California by the Héroult Process.* **R. L. Phelps.** (Electrochem. Ind., N.Y. 5. pp. 318–319, Aug., 1907. From the "Mining and Scientific Press," July 20, 1907.)—Details are given of the first trial of the Héroult furnace and process for smelting the magnetite ores of Shasta County, California. The ore contains from 68 to 70 per cent. iron and little impurity, and is found in conjunction with limestone, which can be used for smelting purposes. Charcoal is used as reducing agent. Electric energy is obtained from the Northern California Power Co. at the rate of $12 per e.h.p.-year, and in the form of a three-phase current, at 60 cycles and 22,000 volts pressure. It is estimated that the ore can be converted into pig-iron in the Héroult furnace, and the latter delivered in San Francisco at a cost of from $15 to $18 per ton, whereas imported pig-iron is now selling in that city for $30 to $32 per ton. The furnace is elliptical in form, and has three vertical carbon electrodes and a neutral electrode formed by the bottom of the furnace. The vertical electrodes are held in water-cooled copper holders. The current of 30,000 amps. at 80 volts was first turned on to the furnace on June 29, for the purpose of drying the linings and testing the electrodes, and the first charge was placed within it on July 4. A failure of the cooling-water pump necessitated a stoppage during this first run, but at a later date it was reported that a 5-ton charge of iron of excellent quality had been tapped.

J. B. C. K.

1148. *Lash's Steel Process.* (Electrochem. Ind., N.Y. 5. pp. 344–345, Sept., 1907. U.S. Pats. 856,351, 860,922, 862,978.)—H. W. Lash smelts steel of good open-hearth quality from a mixture of iron oxide with pig or cast iron. Scrap, wrought iron or steel are unsuitable, because the added metal should contain a high percentage of oxidisable metalloids and metals such as Mn. The pig must be finely divided, and the ore crushed, as the materials must be intimately mixed. Magnetic iron sand concentrates are particularly thought of, and their titanium contents are not objectionable. The quantity of pig should not exceed that of the iron oxide in the ore; it may be smaller. The other additions are finely-ground coke; lime, sand, or fluorspar as flux; and saw-dust or bituminous coal to render the mass porous. Experiments have been made with open-hearth furnaces at the Carbon Steel Co. of Pittsburg, and at Niagara Falls by FitzGerald and McBennie with one-fourth pig and three-fourths ore in electric furnaces; yields from 96 to 98 per cent. were obtained. Experiments with Héroult furnaces (at Remscheid, Westphalia), and with Stassano furnaces are planned. The process has been taken up by the Lash Steel Process Co., of Cleveland, Ohio, and by the Canadian Lash Steel Process Co., of Toronto.

H. B.

1149. *Reduction of Vanadium, Molybdenum, Titanium, and Tungsten from Oxides.* (U.S. Pat. 858,329. Electrochem. Ind., N.Y. 5. p. 322, Aug., 1907. Abstract.)—F. M. Becket claims a process which is carried out in two stages.

In the first the oxide is reduced from a high to a lower state of oxidation by a non-metallic agent, *e.g.*, C, H, CO, a hydrocarbon, producer gas or water gas, in an ordinary furnace. In the second stage the reduction is completed, by the use of SiC, in the electric furnace. The advantage of the combined process lies in the use of relatively inexpensive reducing agents in the first stage, and a comparatively small amount of Si C in the final reduction. F. R.

1150. *Vanadium from Sulphide.* (U.S. Pat. 858,828. Electrochem. Ind., N.Y. 5. p. 822, Aug., 1907. Abstract.)—F. M. Becket claims the reduction of vanadium sulphide by smelting in the electric furnace together with Si or a Si alloy; and also the direct production of V alloys by the use of a suitable Si alloy, as Si-Ni or Si-Fe. The process has been partially described in Abstract No. 878 (1907). F. R.

1151. *Vanadium and Alloys.* (U.S. Pat. 858,825. Electrochem. Ind., N.Y. 5. p. 822, Aug., 1907. Abstract.)—F. M. Becket produces vanadium or its alloys low in carbon from oxides of the metals by reduction with Si and C, preferably as SiC. A basic flux, such as lime, is used to combine with any SiO_2 present or formed by oxidation of Si. High yields are obtained. F. R.

1152. *Alloy for Iron and Steel.* (U.S. Pat. 858,827. Electrochem. Ind., N.Y. 5. p. 822, Aug., 1907. Abstract.)—F. M. Becket claims the use of an alloy for addition to molten iron or steel, which contains principally Ti, Ca, Al, and Fe. Its melting-point is lower than that of ferro-titanium, and it is said to be more readily diffused through the mass of metal treated. It is produced by the reduction of a mixture of the oxides with carbon in the electric furnace. The following are examples of percentage composition of alloys of the kind claimed:—

	Ti	Ca	Al	Fe	Si	C
(*a*).........	50·67	8·82	22·7	11·88	4·2	1·86
(*b*).........	26·24	5·8	1·55	50·98	11·78	8·69

F. R.

1153. *Electric Zinc Furnaces.* (U.S. Pats. 859,182, 859,183, 859,184, 859,185, 859,186, 859,187. Electrochem. Ind., N.Y. 5. pp. 823–824, Aug., 1907. Abstracts.)—The six patents of F. T. Snyder concern three different processes and furnaces for the electric smelting of sulphidic zinc-lead ores. Common to the processes is the idea that fairly pure zinc vapours will condense to liquid zinc, while impure vapours will condense as zinc dust. The first two patents describe a stack furnace with a suspended stout carbon electrode dipping into the kathode, molten lead. The ore is roasted down to 8 per cent. of sulphur, and the charge is made up of this ore, coke, and fluxes such as to yield a slag of high melting-point, rich in Si (over 50 per cent.), and not retaining any Zn. The charge fills the stack, the electrode being immediately surrounded by coke; the electrode penetrates through the slag, the charge rests on it. The lower part of the furnace wall is formed by a water-cooled chamber, on which the congealed slag forms a lining; at the end of the walls wells are left for the condensing zinc. The reduced lead sinks into the kathode and is ladled out. The CO and Zn vapours are kept under a rather high pressure in the central part of the furnace; zinc dust is deposited, which, descending again into the hotter portions of the furnace, finally becomes sufficiently concentrated as vapour to liquefy and to collect in

the zinc well. The next two patents deal with a different process. An induction smelting furnace and a condenser for the liquid zinc are alongside one another, and above the two is the pre-heating chamber. The electrode of the induction furnace leaves room for lead wells on both its sides. In the first process there were two heat stages; in this second process the heat is raised in four stages. U.S. Pat. 859,187 also suggests the replacement of the induction furnace by electrodes dipping into wells. The last two patents refer to a furnace more resembling the first type. The idea is, however, to get all the zinc condensed as dust in stacks and flues surrounding the furnace proper, there being three stacks at angles of 120°, and then to let the still hot dust pass down flues into a second furnace underneath the first where the zinc is smelted. The electrodes of the first furnace are cylindrical shells, through which granular carbon is fed down; the shell does not reach down to the slag. The slag is to contain 40 per cent. of silica, 30 per cent. of lime, and 15 per cent. of iron, and in order to have large volumes of gas present—to facilitate the deposition of zinc dust—the iron is added as carbonate (siderite), and the charge is wetted. Some iron is also to be reduced, and to float on the molten lead, with the object of keeping the matte free from zinc. H. B.

1154. *Manufacture of Phosphorus in the Electric Furnace.* (Electrochem. Ind., N.Y. 5. p. 378, Sept., 1907.)—The temperature required in an electric phosphorus furnace may be reduced from 3,500° to 2,700° F. by using the phosphate charge in a fine powder; and to obviate loss by unreduced dust being carried over into the condenser, G. C. Landis (U.S. Pat. 859,086) briquets the finely-powdered charge before treatment in the furnace. The phosphate, sand, silicate, and coke are each crushed separately, calcined at a red heat, preferably in a rotary calcining furnace, then ground to about 18-mesh, and the desired mixture made into briquets with tar or other binding material. W. H. Si.

1155. *Monnot Compound Metals.* (U.S. Pats. 851,684 and 851,998. Metallurgie, 4. pp. 569–570, Aug. 22, 1907. Abstracts.)—The compound metals of the Duplex Metal Co., of Chester, Pennsylvania, are made according to the patents of J. F. Monnot. Steel or other metals are coated with a layer of molten copper, bronze, aluminium, &c., and then rolled or drawn to wire. In making steel-copper wire suitable for electrical conductors the cylindrical steel ingot or billet is suspended by a frame in a crucible containing the fused copper. A plate or flange is fixed to the lower end of the ingot, and this plate is provided with an annular groove into which a cylindrical shell or mould fits. This shell is first held by the frame, and lowered into the bath as soon as the ingot is fully immersed. The space between the ingot and the shell is thus filled with copper. The whole operation is rapid, and the compound ingot is, after removal of the shell, passed through the rollers. The shell had previously been rubbed with plumbago to prevent adhesion of the molten copper, and the ingot had undergone a preparatory treatment in an acid bath and in a flux of fluorspar. The second patent concerns an alternative suspension and arrangement of the bottom plate. H. B.

1156. *Manufacture of Steel Dies.* (U.S. Pat. 857,926. Electrochem. Ind., N.Y. 5. pp. 325–326, Aug., 1907. Abstract.)—The purpose of the invention is

to produce steel dies directly from the object of which a reproduction is desired. The method of G. F. Diez consists in depositing iron by aid of the electric current upon the surface of the object, and then in treating the matrix obtained so as to convert it into a high grade of steel. The plating bath is made up of saturated solutions of ferrous sulphate and of sodium bicarbonate in the proportions of 1,000 c.cm. to 125 c.cm. The anode is of iron, and an e.m.f. of 0·70 to 1·5 volts is employed between the terminals of the bath with the temperature of the electrolyte at 21° C. The object to be coated with iron is hung by a fine copper wire at a distance of from 10 to 25 cm. from the anode. The time required to produce the matrix depends upon the purpose for which the die is required, and varies from three to fifteen days. In order to convert the soft iron matrix into steel, the die is heated in a crucible for 8 hours at a red heat with a mixture of charcoal powder, steel filings, and potassium ferrocyanide made into a paste with oil, and it is then tempered in the usual way. J. B. C. K.

1157. *Electrodes for Arc Discharges.* (Brit. Pat. 18,600 of 1906. Engineer, 104. p. 225, Aug. 30, 1907.)—The electrodes for the electric treatment of gases, such as the oxidation of atmospheric nitrogen, should be conductors of the second class, metallic oxides. As they are difficult to make, H. Pauling applies square electrodes of iron, provided on their lower surface with cooling ribs, and oxidises the ends of the electrodes by the arc discharge. For this purpose the electrodes are first brought into contact to become incandescent. They are then separated so that the arc-flame starts from the upper portions of the ends where the iron is oxidised. As the electrodes are arranged horizontally, the fusing oxide does not drip off, and the cooling ribs prevent evaporation. H. B.

1158. *Improvements in Electric Welding.* (Electrical Times, 32. pp. 822–824, Sept. 5, 1907.)—Various new applications of the Thomson process are described and illustrated. The surfaces of metal plates have points or projections formed on them, which enable them to be welded together by causing local heating when placed between the clamps of the welding machine. In this way small pulleys are made from stampings on the machine described. Another method of welding thin material consists in causing the edges, when heated, to be turned up against each other, and then hammering or pressing the upturned portion down against the surface of the material. Steel bands varying from ⅝ in. to 1½ in. wide by No. 20 to 27 gauge are welded in this manner on an automatic machine at the rate of 350 to 600 welds per hour. Hollow-handled cutlery is made by welding the handle, which is drawn from a sheet, to one side of a specially-shaped bolster, the blade being welded to the other side. 250 to 300 welds are made per hour, the welding machine being operated by a boy. An advantage of the welded joint is that the plating liquid cannot enter the hollow handle and corrode the metal. Electrically-welded wire netting is made by automatic machinery in which the wires are fed downwards from reels placed at the top, the cross-wires being fed from another reel at the side, and cut to the length required. A number of welders, corresponding to the number of vertical wires, then weld the wires together where they intersect, and the operation proceeds automatically. Automobile crankshafts are made by welding the two central portions, which are drop forgings, to straight rods consisting of drawn steel shaped to about the finished size. The manu-

facture of hexagon-headed bolts by electric welding is also referred to. [See Abstracts Nos. 814 and 815 (1906).] Welders for chains and harness rings are described, particulars being given of an automatic welder for fine gauges of wires. Mention is made of an electric welder of 90 kw. capacity recently connected to a public single-phase power supply in London, special regulating apparatus being employed to prevent undue fluctuation of pressure. To facilitate the working of welders on polyphase circuits without unbalancing the phases, Elihu Thomson has patented a method of winding the transformers. A new type of welding transformer, designed by Berry and Wallis-Jones, is described and illustrated. R. J. W.-J.

1159. *Westinghouse Automatic Synchroniser.* **P. MacGahan and H. W. Young.** (Elect. Journ. 4. pp. 485–496, Sept., 1907.)—The authors first give descriptions of two forms of the ordinary type of synchroniser, and then deal in detail with the automatic synchroniser devised by the Westinghouse Co. [Abstracts Nos. 878 and 1265 (1905).] In the latest design of this instrument, each of the solenoids which control the see-saw lever is subdivided into eight sections, one set of alternate sections being connected in series and then across the bus-bars, and the other set being similarly connected across the incoming machine. The connections are so arranged that when the incoming machine is in phase with the bus-bars, the right-hand solenoid exerts its strongest pull, while the left-hand one exerts no pull at all. These conditions are reversed if there is phase opposition. When the machines are nearly in synchronism the see-saw lever oscillates very slowly, but if the frequencies differ appreciably, its oscillations are much more rapid. One end of this lever carries a platinum-tipped contact spring and the cylinder of an air dash-pot, whose piston is (through suitable linkwork furnished with controlling springs) connected to a segment of insulating material mounted loosely on a spindle whose axis passes through the bearing of the see-saw lever. This segment carries a contact strip let into part of its surface, and resting against the strip is a second contact-spring. When the movable contact-spring fixed to the see-saw lever moves over the surface of the segment far enough to reach the contact strip, the circuit of the relay is closed and the main switch operated. The segment is normally maintained in a definite position by a controlling spring, and if the see-saw lever oscillates very slowly the piston of the dash-pot will not move relatively to its cylinder, the air being allowed sufficient time to enter the dash-pot. The relay circuit will then be closed as soon as the moving contact-spring reaches the contact-strip on the segment. Should, however, the oscillations be too rapid (owing to a large difference of frequencies) the piston will be pulled up by the cylinder, and a rotation of the segment will take place, during which a pin projecting from the segment lifts the fixed contact-spring clear of the contact-strip and so prevents the relay circuit from being closed. The relay circuit is adjusted to be closed in advance of the proper moment for closing the main switch contacts, so as to make sufficient allowance for the time-element of the main switch. This type of synchroniser is particularly well adapted for use with large units, and greatly hastens the operation of synchronisation. A. H.

1160. *Lackie's Maximum Current Indicator.* (Elect. Engin. 40. p. 255, Aug. 23, 1907.)—In this arrangement there is a pivoted lever having at one end a friction-wheel and at the other a core movable in a fixed solenoid.

When current is passed through the solenoid the lever is tilted so as to bring the friction-wheel into contact with another friction-wheel which is mounted in fixed bearings and is rotated by clockwork, electrically or in any other suitable manner. By means of the friction-wheels a weight is drawn along the pivoted lever in a direction away from the fulcrum thereof, so as to counterbalance the attraction of the solenoid on the core. When this attraction is overcome the friction-wheels are separated again, and the weight, or an indicator moved thereby, remains in the position at which the attraction was overcome, and thus serves to indicate the maximum current. The friction-wheel on the lever may move the weight by winding up a cord passing through a hole in the weight, and having a projection for engaging with the weight, or by turning a screw having a nut thereon, or by a rack and pinion, &c. C. K. F.

1161. *Influence of Iron-losses on Resonance.* **G. Benischke.** (Elektrotechnik u. Maschinenbau, 25. pp. 683–685, Aug. 18, 1907. Écl. Électr. 52. pp. 441–443, Sept. 28, 1907.)—The influence of eddy currents and hysteresis in the inductive portion of a resonance circuit is worked out on the assumption that each may be represented by equivalent currents in a secondary circuit, and that the current follows a sine law. Expressions are derived for the value of the current in the circuit, the angle of phase displacement, and the conditions of resonance. In conclusion it is observed that the presence of eddy currents and hysteresis delays the attainment of resonance, and reduces the resonance current. Also that their effects increase with the frequency. For a discussion of the effect of using imperfect condensers, see Abstract No. 1780A (1906). J. D. C.

1162. *Notation for Polyphase Circuits.* **C. H. Porter.** (Elect. Journ. 4. pp. 497–505, Sept., 1907.)—The writer points out the necessity of adopting some consistent form of notation if slips are to be avoided in connection with problems relating to polyphase circuits. The diagram of connections should in each case be drawn and lettered, and in dealing with the various e.m.f.'s and currents the symbols by which these are denoted should be provided with suffixes to indicate the direction which is considered positive. Thus if A, B, C denote the three corners of a Δ-circuit, E_{AB} would be taken to represent a voltage whose instantaneous value is considered positive if acting from A to B, and negative if acting from B to A, so that we should have $E_{AB} = -E_{BA}$. The usefulness of the notation is illustrated by a number of problems. A. H.

1163. *Lightning Protection for Power-plant Chimneys.* **N. M. Hopkins.** (Eng. News, 58. pp. 203–206, Aug. 22, 1907. From Journ. of the Amer. Soc. of Naval Architects, May, 1907.)—The author gives an account of the system of lightning protection designed by him for use in connection with the power-plant chimneys at the U.S. Navy yards. The lightning conductors are 7-strand copper cables, each strand being a No. 10 B. & S. gauge. Two conductors are used for chimneys not exceeding 50 ft. in height, three for chimneys between 50 and 100 ft., and four for chimneys above 100 ft. The conductors are attached securely, both mechanically and electrically, to independent pure copper earth-plates, 8 ft. × 8 ft. × ⅛ in. They are secured to the exterior of the chimney at intervals of not more than 10 ft., by bronze or brass brackets, whose shanks are at least 1 in. wide × ⅛ in. thick, and enter the masonry a distance of at least 6 in. The top of the chimney is

covered by a heavy copper spider, the radial arms of which run out to the lightning rods. The top of each rod is fitted with a two-point aigrette.
A. H.

1164. *New Types of Electric Drive.* **J. Sahulka.** (Elektrotechn. Zeitschr. **28.** pp. 852–854, Aug. 29, 1907. Paper read before the Verband Deutsch. Elektrotechniker, Hamburg. Écl. Électr. **52.** pp. 425–428, Sept. 21, 1907. Electrical World, **50.** pp. 573–574, Sept. 21, 1907.)—Two types of electric drive invented by the author are described. In the first, the main motor, which may be of any type whatever, is constructed with both its members free to rotate. The inner member is mounted on the shaft to be driven, or is suitably geared to it. The outer member is geared to a shunt-wound continuous-current generator, which supplies current to a series-wound motor geared to the shaft to be driven, so that in general this shaft is driven partly by the main motor, partly by the series-wound auxiliary motor. Speed control is obtained by means of a field rheostat in the shunt circuit of the generator. At starting, the generator is open-circuited, and the outer member of the main motor runs up to full speed. The generator circuit is then closed on the series motor, and very smooth starting of the shaft to be driven is thereby obtained. While sharing with the Ward-Leonard system the high efficiency due to the absence of rheostats in the main circuit, the author's arrangement has a number of additional advantages: the generator and series motor need be of only half the output of the main motor; at starting, a large fraction of the kinetic energy of the rotating members is utilised in supplying power to the driven shaft; a direct drive by means of the main motor alone is possible at the highest speeds, with a considerable gain of efficiency, by blocking the outer member of this motor; and lastly, the system admits of regenerative control on down gradients. In the second system devised by the author, the driven shaft or shafts receives power from single-phase commutator or polyphase induction auxiliary motors, current to which is supplied from the rotor of an induction motor. A suitable brake is provided for clamping the rotor of this motor, in which case the induction motor plays the part of a stationary transformer. There is no sparking trouble at starting when using commutator motors, as the frequency of the currents supplied to them by the rotor is initially extremely low.
A. H.

1165. *Electric Driving of Textile Machinery.* (Schweiz. Elektrot. Zeit. **4.** pp. 853–855, July 27; 866–868, Aug. 3, and pp. 878–879, Aug. 10, 1907.)—A description is given of the system recently patented by the Oerlikon Co. of driving embroidering machines by means of induction motors. By altering the number of poles, the speed may be halved. Intermediate speeds are obtainable by a mechanical method, involving the use of a special pulley around which passes the driving band. This pulley consists of a fixed and a movable half, each provided with a number of claws lying on a conical surface. The claws engage with each other, and the driving band lies in the groove formed by the intersection of the two conical surfaces. By causing the movable half of the pulley to approach the fixed half, the effective diam. of the pulley is increased, the tension of the driving band being maintained constant by the aid of a jockey pulley. The advantage of this system over rheostatic speed control lies in its high efficiency.
A. H.

GENERATORS, MOTORS, AND TRANSFORMERS.

1166. *New Type of Coil for High-voltage Alternators.* (Electrician, 59. pp. 788–789, Aug. 30, 1907.)—The new method of constructing the coils of high-voltage alternators devised by the Oerlikon Co. has for its special feature the bending to the required shape of the flat copper strip used in winding the coil *previous to its insulation.* The strip having been bent is then insulated (with cloth or paper strip or micanite), so that all danger of damaging the insulation of the conductors in the process of winding, while bending them, is done away with, and an absolutely reliable form of insulation is secured. The individual turns having been insulated, the whole is impregnated and provided with a seamless external covering of micanite before being placed in the slots. This method of winding is obviously applicable only to machines with open slots. A. H.

1167. *New Type of Field Magnet Construction for Turbo-alternators.* (Elect. Engineering, 2. pp. 895–896, Sept. 12, 1907. Écl. Électr. 53. p. 84, Oct. 5, 1907.)—The method of construction described has been patented by Bruce Peebles and Co. and J. L. la Cour [Brit. Pat. 18,582 of 1906]. It is more particularly intended to be used in connection with cast steel field-magnets the number of whose poles is greater than 4—in which case the winding-on of the wire or strip around the poles in a lathe becomes impossible, as the angle between the centre-lines of adjacent poles becomes so small that the poles are in each other's way. According to the inventors, the magnet is formed in two parts, each carrying half the number of complete poles and shoes (consisting of *alternate* poles), and having a boss approximately half the axial length of the magnet. The overhanging extensions of the poles of each half have a dove-tail along their base, and the part of the boss between the poles has a dove-tail groove, so arranged that when the several magnet poles are wound the two parts slide into interlocking engagement with each other and form a single magnet wheel. A. H.

1168. *Method of Compounding Alternators.* J. Rezelman and J. Perret. (Écl. Électr. 52. pp. 325–330, Sept. 7, 1907.)—The principle of the method of compounding alternators by the transverse reaction of the armature is explained in Rezelman's *Die Vorgänge in Ein- und Mehrphasengeneratoren,* 1906. Interpoles with no windings are used in direct-current machines. The smaller the reluctance of the auxiliary circuit and the higher the saturation of the principal circuit the greater is the compounding effect. With alternators this method would produce a very distorted e.m.f. The authors use a rotor analogous to those generally used in induction motors, the winding being distributed so as to get a sine-shaped wave. The principal magnetic circuits following the axes of the poles are strongly saturated, and the transverse circuits have small reluctances. The theory of the method is worked out and a numerical example is given to show that it is possible to compound an alternator by merely giving it special dimensions without using any auxiliary apparatus. A. R.

1169. *Testing of Generators and Transformers.* (Elektrotechnik u. Maschinenbau, 25. pp. 678–679, Sept. 1, 1907.)—The experience gained by the

Oerlikon Co. has led it to propose the following definitions and methods of testing. The efficiency η of a machine or transformer whose normal rating is A kv.a. at a power-factor $\cos\phi$ is to be taken to denote the ratio—

$$\eta = \frac{A \cos\phi}{A \cos\phi + l + i_1^2 r_1 + i_2^2 r_2 + i_1 . c},$$

where l is the no-load loss, in kw., at the normal voltage, frequency and speed, after allowance has been made for all copper losses taking place at no load; $i_1^2 r_1$, $i_2^2 r_2$ denote the copper losses in the two windings; and $i_1 c$ the loss due to brush contact resistance in machines having commutators or slip-rings, the constant c having the mean value of 0·002 for carbon brushes. The resistances r_1 and r_2 (in kilo-ohms) of the two windings are to correspond to a temperature of 60° C. The losses $i_1^2 r_1$, $i_2^2 r_2$ are to be determined by ordinary resistance measurements. It will be noted that the above definition takes no account of the additional losses at full load; the exact measurement or calculation of such losses is in general impossible, and their amount generally lies within the limits of experimental errors. The voltage drop of a machine or transformer of A kv.a. normal rating at a power-factor $\cos\phi$ and normal voltage E is the voltage-rise e which occurs on throwing off the load. When testing alternators, a load of power-factor approximately equal to zero may be obtained by the use of a feebly excited synchronous motor. The voltage drop corresponding to any other $\cos\phi$ and the same current is then determined by the aid of Kapp's diagram. The insulation test of the windings should, wherever possible, be carried out by the aid of an e.m.f. generated in the windings themselves, each terminal of the high-voltage winding being in succession connected to the frame and to one terminal of the low-voltage winding. The testing voltage may be raised 20 per cent. above the normal e.m.f. by increasing the frequency, and should be applied for 30 minutes. Should it be impossible to use the winding itself as the source of the testing e.m.f., a special testing transformer may be used, whose e.m.f. follows the sine law. One terminal of the transformer is connected to the frame and the low-voltage winding, and the other to the high-voltage winding. The maximum value of the testing e.m.f. should in every case be ascertained by the use of a needle-point spark-gap, the corresponding voltage being found from the table of sparking voltages prepared by the American Institute of Electrical Engineers. A. H.

1170. *Oerlikon Single-phase Series Motors.* H. Behn-Eschenburg. (Schweiz. Elektrot. Zeit. 4. pp. 397–398, Aug. 24, 1907.)—The 250-h.p. motors constructed for the Seebach-Wettingen line [Abstract No. 242 (1906)] originally had armatures with open slots, and the high harmonics generated by the teeth produced serious disturbances on a neighbouring telephone circuit. These armatures were also provided with resistance connectors. The armatures have now been replaced by others in which the winding is placed in skewed tunnels, and in which the resistance connectors have been entirely omitted, the transformer e.m.f. in the short-circuited coils being wiped out by commutating poles provided with the winding patented by the author. The new armatures run very satisfactorily; and the disturbances on the telephone line have practically disappeared. Some 500-h.p. motors of the gearless type, intended for a speed of 60 km. per hour, are now in course of construction, and these will, in the first instance, be provided with resistance connectors. A. H.

1171. *Commutation Losses during the Starting of Single-phase Commutator Motors.* **J. Bethenod.** (Écl. Électr. 52. pp. 289–298, Aug. 31, 1907.)—The case of an ordinary single-phase commutator motor with a compensating winding in series with the armature is first considered. In this case the dynamic e.m.f. in the short-circuited windings can be completely neutralised, and so only the static e.m.f. due to the variations of the inducing flux has to be considered. If we suppose that the start is effected at constant torque —that is, with constant current—then the power P, lost in commutation losses at all instants during the start, is constant. It may be written in the form $\lambda\Omega^2$, where λ is a constant and $\Omega(=2\pi f)$ is the velocity of pulsation. The author next considers the commutation losses in single-phase series motors when the field of commutation is independent of the velocity. This is the case in those motors which have a complementary statoric winding having the same axis as the series compensating winding and in which the current is proportional to the principal current and approximately in quadrature with it. If we suppose that the angular velocity of the rotor at the time t after the start is ω, we find that, in this case, $p=\lambda(\Omega-k\omega)^2$, where k is a constant independent of the velocity. Making the supposition that the acceleration is constant, so that $\omega=(v\Omega/\mathrm{T})t$, where v is the ratio of the velocity at the end of the start to the synchronous velocity (Ω), we get at once $P_2=P_1[1+k^2v^2/3-kv]$, where P_2 is the average power lost during the start owing to the commutation losses. During normal working $kv=1$, and hence $P_2=P_1/3$. Hence the use of the auxiliary field reduces the losses to one-third their value. To reduce the losses to a minimum we make $kv=3/2$, and hence $P_{\text{min.}}=P_1/4=\lambda\Omega^2/4$. On the other hand, the commutation losses during normal working will not be zero, but will be $\lambda\Omega^2/4$. For suburban traction where stoppages are frequent this may not be serious, but, if necessary, by reducing the excitation to two-thirds of its initial value perfect compensation could be obtained. Finally, the losses in single-phase series motors having the field of commutation proportional to the velocity (Latour motors, series motors having compensating windings in parallel with the armature, &c.) are considered. In this case we have $p=\lambda(\Omega-k\omega^2/\Omega)^2$. In repulsion motors and in the Latour motor k is always equal to the square of the number of pairs of poles, but for other motors k can be varied between certain limits. The mean commutation losses P_3 during the start are given by—

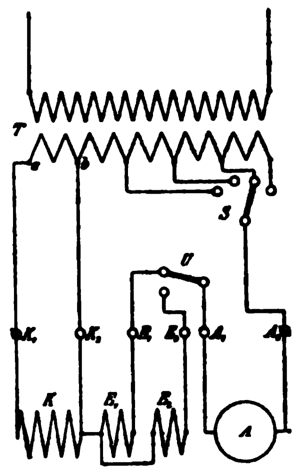
$$P_3=(1/\mathrm{T})\int_0^{\mathrm{T}}\lambda(\Omega-k\omega^2/\Omega)^2dt=P_1(1-2kv^2/3+k^2v^4/5).$$

If we wish to obtain "perfect commutation" at the normal speed, kv^2 must equal unity, and thus $P_3=(8/15)P_1$. We also see that $P_{\text{min.}}=(4/9)P_1$, and it has this value when $kv^2=5/3$. When k can be varied, we may maintain $kv^2=5/3$, during the start, and then make $kv^2=1$ for the normal working. A study of these commutation losses is obviously of great importance in motors for traction work where the stoppages are frequent. A. R.

1172. *Use of Synchronous Motors as Phase Compensators.* **W. Nesbit.** (Elect. Journ. 4. pp. 425–433, Aug., 1907.)—If a synchronous motor be used as a phase compensator pure and simple at the far end of a transmission line, its kv.a. capacity will have to be relatively large, and the compensator will be costly. The author draws attention to the following points: (1) A great gain will result by utilising the synchronous motor as a motor, instead of merely

allowing it to run light; (2) it seldom pays to raise the power-factor by the use of synchronous motors to values higher than 90 or at most 95 per cent. When induction motors are replaced by synchronous motors in order to improve the power-factor, the exchanges should be made on the larger sizes, so as to reduce the number of synchronous motors to a minimum. A. H.

1173. *Improved Form of Siemens-Schuckert Single-phase Motor.* **R. Richter.** (Elektrotechn. Zeitschr. 28. pp. 827–830, Aug. 22; Discussion, pp. 771, Aug. 1, and 799, Aug. 8, 1907. Paper read before the Verband Deutsch. Elektrotechniker, Hamburg. Rev. Electrique, 8. pp. 143–144, Sept. 15, 1907.)—In the original series motor constructed by the Siemens-Schuckert Works, the stator was provided with four distinct windings: (1) an exciting winding; (2) a distributed compensating winding; (3) a series and (4) a shunt auxiliary winding, these latter surrounding a single tooth which was used as a reversing pole. The construction of the stator in the most recent type of motor has been greatly simplified, with a reduction in the size and weight of the stator, by combining the four windings just enumerated into a single wave winding. The connections of the new motor are shown diagrammatically in the Fig., T being the transformer supplying current to the motor, A the armature, E_1 and E_2 those sections of the wave winding which serve as the exciting windings; only one of these is in use at a time, depending on the direction of rotation. U is the reversing switch. K is that section of the field winding which serves the double purpose of a compensating winding and of the windings (3) and (4) enumerated above. The substitution of a single for four distinct windings, besides being a great constructional simplification, leads to reduced copper losses and a simpler form of reversing switch. [See also Abstract No. 885 (1906).] A. H.



1174. *Prevention of Sparking in Single-phase Commutator Motors.* (Electrical World, 50. pp. 529–530, Sept. 14, 1907.)—The use of multiple armature windings for the purpose of preventing sparking has formed the subject of numerous patents [Abstracts Nos. 57, 308, and 405 (1907)]. This method is effective at starting and low speeds, but it is disadvantageous at high speeds, as the rapid interruptions of the current in the individual windings then cause serious sparking. At high speeds a single winding is to be preferred, since both the current and the field have small values. In order to combine the advantages of a multiple winding at starting and low speeds with those of a single winding at high speeds, M. C. A. Latour has patented the following arrangement. The armature is provided with a multiple winding, and with a double set of brushes, one set being rigidly fixed and the other movable. The two sets are electrically connected, and at starting are in line with each other, the tangential width of either set being sufficiently small to prevent its bridging two segments belonging to the same winding. The armature will therefore act as a multiply-wound one. As the speed increases, the movable set of brushes is gradually shifted relatively to the

fixed set (by means of a suitable automatic electromagnetic device), the arc of contact being thereby increased until two segments of the same winding are bridged, when all the windings are permanently paralleled and the armature behaves like a single-winding armature. A. H.

1175. *Synchronous Motors as Phase Compensators.* R. E. Hellmund. (Elect. Rev., N.Y. 51. pp. 281–283, Aug. 24, 1907.)—A synchronous motor when used as a phase compensator at the receiving end of a transmission line enables a saving to be effected (1) in generating plant capacity and (2) in line copper. On the other hand, the total capacity of the plant at the receiving end will be increased, since the synchronous motor must be large enough to deal with the entire wattless current of the load. Whether in any given case it is advisable to provide a synchronous motor or not, depends on the relative amounts of the saving effected by the use of such a motor and of the additional outlay which it involves. The problem largely depends on the fraction of the total load which may be adapted to be driven by a synchronous motor, and the author gives tables by the use of which the solution of this problem is facilitated. A. H.

1176. *Testing of Transformers.* C. F. Guilbert. (Écl. Électr. 52. pp. 258–260, Aug. 24, 1907.)—Transformers are usually tested either by the method of "separate losses" or by Sumpner's opposition method. The latter method requires two transformers for the same voltage, each of which has the same efficiency at the same load as well as a small auxiliary transformer. The first method neither gives the temperature-rise of the transformer under load nor its regulation. It neglects also the eddy currents in the windings, and so the efficiencies obtained by this method are too high. The second method only gives the regulation at zero power-factor, and as the fluxes of induction are not the same the efficiencies of the two are not equal. The author has improved on Sumpner's method so as to make it applicable for measuring the efficiencies at various power-factors. He first gives the theory of Sumpner's method, using Steinmetz's method of equivalent networks. The equations show that the power supplied to the auxiliary transformer only represents the ohmic losses in the whole system in particular cases. The pressure at the secondary terminals of the auxiliary transformer is represented by two terms. The first is nearly equal to the sum of the voltage drops in the windings and in the leakage inductances, and is due to the currents whose ampere-terms balance in the two transformers. The second term is independent of the load, and depends only on the applied pressure. It corresponds to the difference in the voltage drops in the primary windings at no load. The equations show that this second term only vanishes when the two transformers are exactly the same and when the current supplied has a certain value. In practice, however, with modern transformers, the second term is negligible, as the power absorbed is only about the thousandth part of that represented by the first term. When the transformers are identical the source of supply furnishes the magnetising power, and the auxiliary transformer the power absorbed in heating the windings. The efficiency found in this way is the efficiency for an inductive load. In order to find how the transformers will act on non-inductive loads it is necessary to introduce in the secondary circuit an e.m.f. of which the phase with respect to the applied voltage can be regulated. One method is to put an inductive coil in series with the primary of the auxiliary transformer. A better method is to employ a small alternator keyed to the shaft of the generator supplying the electric

power in such a way that the phase-difference between their e.m.f.'s can be varied. When testing polyphase transformers an induction motor having a wound rotor can be advantageously used instead of the auxiliary transformer. The phase-differences can be obtained by means of wattmeters, ammeters, and voltmeters. If we adopt Sumpner's method with two-phase transformers and cross the phases of the auxiliary transformer we get the efficiency for a power-factor of unity. In conclusion, the author extends Kapp's diagram to the case considered. By its aid we can see at once what happens when a boosting voltage having any phase-difference with the primary is introduced into the secondary circuit. A. R.

1177. *Initial Values of the Primary Current and the Secondary Voltage when a Transformer is put into Operation.* **T. Jensen.** (Electrical World, 50. pp. 521–523, Sept. 14, 1907.)—The transformer experimented on had a voltage ratio 100000/440, a capacity of 10 kw., and was connected with a generator having a frequency of 60. It was operated, however, so that the maximum secondary pressure was 50 kilovolts, and so the magnetic core was far from being saturated. Oscillograms are shown of the primary current and voltage and of the secondary voltage. The maximum rush of primary current was obtained when the switch was closed at the instant when the primary p.d. was zero. When the switch was closed at the instant the primary p.d. was a maximum, there was no appreciable rush of current, but a violent vibration of the primary p.d.-wave occurred. The oscillogram also shows that in this case when the primary switch is closed the secondary p.d. rises at once to its full value. It was noticed that on closing the primary circuit vibrations took place in both the supply p.d. and current waves, the number of zigzags produced in each wave being three. The vibrations observed corresponded in frequency to the number of slots on the armature. A. R.

1178. *Test of a de Faria Electrolytic Transformer.* **O. de Faria.** (Bull. Soc. d'Encouragement, 109. pp. 874–885, July, 1907.)—The de Faria electric "valve" differs from the Nodon "valve" solely in the shape of the electrodes, which are claimed to secure automatic circulation of the electrolyte. Oscillograms are given of the alternating and rectified p.d.'s of a set (4 cells). Wattmeter tests of the efficiency of a 4–5-amp. set at the *Laboratoire Central* showed a mean efficiency of 58 per cent., the test lasting 7½ hours; the hottest part of the electrolyte rose to 48·8° C. At this temperature the efficiency was in one case even higher than at the lower temperatures. It is stated that the average efficiencies of larger sizes reach the following values: 10-amp., 65–70 per cent.; 30-amp., 65–75 per cent.; 50-amp., 70–80 per cent. Tabulated results of a test of a set charging accumulators are given. L. H. W.

REFERENCES.

1179. *Standardisation Rules of the American Institute of Electrical Engineers.* (Amer. Inst. Elect. Engin., Proc. 26. pp. 1077–1106, July, 1907.)

1180. *Cramp Single-phase Motor.* **W. Cramp.** (Elect. Rev. 61. pp. 240–243, Aug. 9, 1907.)—Experiments carried out on a motor of this type, which is a combination of a transformer and motor [Abstract No. 658 (1907)], confirm the results arrived at by theory. The author claims that by the adoption of this type of motor a considerable saving in copper may be effected in comparison with a motor having a separate transformer. A. H.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

1181. *Raising the Power-factor by Rotary Condensers.* **F. D. Newbury.** (Elect. Engineering, 2. pp. 841–848, Aug. 29, 1907. Paper read before the National Electric Light Assoc.)—There are three cases when rotary condensers are advisable, namely, (1) when trouble is caused by the low power-factor; (2) when their use would diminish the cost of feeders and transformer apparatus; and (3) in designing systems where slow-speed generating units will have to work on a large inductive load. As a rotary condenser has a large leading current with a practically zero power-factor, provision must be made for a very large exciting current. The conditions of operation are favourable to starting directly from the alternating-current mains, but if the drop in the pressure of the system when the condenser starts in this way be too great, an induction starting motor must be used. Good damping qualities are required to prevent phase-swinging, but in this case the starting efficiency is low. In most cases, however, it is better to sacrifice efficiency at the start in order to secure steady working. A. R.

1182. *Parallel Operation of Continuous-current Generators Driven by Turbines and Reciprocating Engines.* (Electrical World, 50. p. 529, Sept. 14, 1907.)—When a turbine-driven, compounded dynamo operates in parallel with others driven by reciprocating engines, the occurrence of a sudden short-circuit or heavy overload causes the turbine-driven machine momentarily to take the greater part of the overload current on account both of its better speed regulation and its lower self-inductance. The turbine-driven machine may thus be damaged before the main circuit-breaker in series with all the generators has had time to act. In order to protect the turbo-dynamo, part of its series winding is reversed, so as to produce a demagnetising effect, and this reversed part is shunted by a reactance coil of very low resistance, which ordinarily takes the bulk of the current. A sudden increase of current will, however, cause the excess current to flow initially mainly through the reversed part of the series winding, the field of the generator being thereby weakened, and an excessive momentary overload prevented. The above arrangement has been patented by E. J. Berg (U.S. Pat. 868,774). A. H.

1183. *Behaviour of Insulators on High-tension Lines near the Sea.* **G. Anfossi.** (Atti dell' Assoc. Elettr. Ital. 11. pp. 326–334, July–Aug., 1907. Elettricità, Milan, 29. pp. 115–117, Aug. 28, 1907.)—Insulators on high-voltage lines near the sea often get covered with an adherent coating of salt and dust, which lowers the insulation of the line, and often, especially in damp weather, prevents it from fulfilling its function. The deposit occurs on the lower surface of the bells and in the interior. The first deposit of salt, being hygroscopic, has the power of retaining the particles of dust, smoke, &c., which are in suspension in the atmosphere, and the deposit continues to increase and is an excellent conductor. All the types of insulators tried suffered in the same way, and several installations are referred to where this trouble occurs. The only absolute remedy—for the use of a larger insulator

only has the effect of slightly prolonging the period of satisfactory operation of the line—is considered to be the provision of a duplicate transmission line, permitting of the periodical washing and cleansing of the insulators of the line not at the moment in use, which method has been adopted by the Western Power Co. on their 100,000-volt power transmission scheme to San Francisco, 50 of the 160 miles of line being close to the sea. L. H. W.

1184. *Methods of Charging for Electric Motive Power in Italy.* G. Semenza. (Elect. Engineering, 2. pp. 827–829, Aug. 29, 1907. Paper read before the National Electric Light Assoc.)—In many cases in Italy a flat rate is adopted, more especially where the current is generated by water-power. The Milan Edison Co. have adopted the meter system. In order to follow the law of variation of the cost of motive power to customers using heat motors of different sizes, and for different numbers of hours per day, so as to meet competition, a special Wright system was applied to each value of the maximum demand. The maximum demand is read monthly, and the same is done with the consumption of energy for each month. Thus the first Wright system is applied with a rate P_1 for an 88 hours' use per month; then a second rate P_2 up to 125 hours' use; from 126–166 hours' use a third rate P_3; a fourth rate P_4 up to 208; a fifth rate P_5 up to 250; and a sixth rate P_6 above 250 hours' use. If a curve be drawn to represent the variations of the rate p of the kw.-hour in accordance with the hour's use h of the Wright system, then $p = \frac{P_1H + (h - H)P_2}{h} = \frac{H(P_1 - P_2)}{h} + P_2$......(1), where P_1 and P_2 are the first and second rates and H the hours' use of the first rate. Equation (1) can be expressed as $y = A/x + B$......(2), a branch of an equilateral hyperbola. In order to apply a sliding scale for the different values of the maximum demand, we ought to have for each of them a special curve corresponding to equation (1). The simplest way to arrive at the group of curves is to start from one of them—say the one relating to the maximum demand of 1 kw. ($M = 1$), which may be called the *fundamental curve*—and obtain the others by multiplying A and B (curve 2) by a certain coefficient of reduction C, where C is a certain function of M, say $C = f(M)$. A rate system of the Manchester-Hopkinson system is also employed, in which a fixed charge A has to be paid per kw. of maximum demand, and a rate B for each kw.-hour consumed. If $W =$ maximum demand in kw., then $Wh =$ energy consumed in kw.-hours, and $p = \frac{AW + BWh}{Wh} = p = A/h + B$......(3), which is of the same form as equation (2). Thus a Manchester-Hopkinson maximum-demand system is equivalent to a Wright maximum-demand system when the fixed rate per kw. is $A = H(P_1 - P_2)$ and the kw.-hour rate is $B = P_2$. A method of incorporating in the schedule the law of variation of the power-factor is also described with reference to an actual curve. This method of charging is applied by installing with each customer a volt-ampere and a maximum-demand indicator, the readings of which are taken at periods corresponding to the billing periods, the bills being made up in the following manner: (1) By charging a fixed rate A for each kilovolt-amp. of maximum demand; (2) by charging a fixed rate B for each kw.-hour; (3) by multiplying the addition of the above two items, viz., kilovolt-amps. $\times$ A + kw.-hours $\times$ B = S by a coefficient C from a special coefficient curve, the values A, B and the curve of coefficients being worked out in accordance with local conditions, cost of energy, and the other ordinary items. C. K. F.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

1185. *Test of 1,000-kw. Curtis Turbo-alternator.* (Elect. Engineering, 2. pp. 412–418, Sept. 12, 1907. Electrician, 59. pp. 883–884. Sept. 13, 1907.) —The set tested, which was constructed by the British Thomson-Houston Co. for the Lancashire United Tramways, consisted of a vertical Curtis steam turbine, mounted on a sub-base condenser, running at 1,500 r.p.m., coupled to a 2-phase alternator, capable of giving a continuous output of 1,000 kw. at a power-factor of 0·8, a p.d. of 7,500 volts, and a frequency of 50. The steam consumption tests were made by measuring the water discharged into the hot-well, the power taken by the air and circulating pumps (52 kw.) being excluded. With a pressure of 150 lbs./sq. in. at the stop valve, a vacuum of 28 in., and the circulating water at a temperature not exceeding 80° F., the full-load steam consumption amounted to 18·5 lbs. per kw.-hour. The regulation at a power-factor of unity was 6 per cent., and the maximum temperature-rise below 40° C. A. H.

1186. *Tests of Three-phase Power Plant for Great Cobar Mines.* (Electrician, 59. pp. 845–846, Sept. 6, 1907.)—Each of the two generating sets tested consisted of a 800-kw., 440-volt, 50-∿ alternator designed for a power-factor of 0·85, coupled to a Browett-Lindley triple-expansion reciprocating engine running at 375 r.p.m. One set was run as a generator, while the other, the pistons of whose engine had been removed, acted as a synchronous motor, and was coupled in parallel with a balanced water load. The power-factor was easily adjusted to the required value of 0·85 by varying the excitation of the second set. The steam consumption tests gave the following results :—

Load.	½-load.	¾-load.	Full load.	20 per cent. overload.
Lbs. of steam per kw.-hour (steam superheat, 75° F.)...	24	22·7	22·4	23·25

The voltage regulation tests showed a permanent rise of only 2½ per cent., and a momentary rise of 4½ per cent. After a 6-hours' run, the max. temperature-rise of any part of the machine was only 28° F. These generating sets are intended for the Great Cobar Mines, Australia. A. H.

1187. *Single-phase Locomotive of the New York, New Haven, and Hartford Railroad.* (Electrical World, 50. pp. 863–870, Aug. 24, 1907. Street Rly. Journ. 30. pp. 278–285, Aug. 24, 1907. Elect. Engineering, 2. pp. 408–411, Sept. 12, 1907.)—[See also Abstract No. 691 (1907).] The locomotives are required to haul a 200-ton train at 65 to 70 m.p.h., and a 250-ton train at 60 m.p.h. on long runs. The motors are of the gearless type, and have to work with direct current at 600 volts, as well as with alternating current. Each locomotive weighs 90 tons, and is carried on two bogie trucks with four 62-in. wheels each. The motors are of the compensated series type, a high power-factor being secured by the use of weak fields, strong armatures, and a large number (12) of poles. Sparking is prevented by resistance between the armature winding and the commutator segments, and by using only one turn per coil. Balancing connections are provided, and the motors are cooled by forced draught, the temperature of the motor being indicated in the driver's cab by an electrical pyrometer. The motors are permanently connected in pairs in series, each pair being separately supplied with power from an auto-transformer when working with alternating current;

details of the controller connections are given for both alternating and direct current, the two groups being controlled on the series-parallel system in the latter case. The unit-switch system is used, operated by compressed air, with electrical control by a master-controller. The overhead collectors, third-rail shoes, main circuit-breakers, &c., are similarly operated, with push-buttons mounted on the master-controller. The trolleys and shoes, and the electrical connections, are interlocked so that it is impossible for both direct and alternating current to reach the motors simultaneously. Tests made on a trial track under service conditions show that the consumption of energy with direct current is 44 watt-hours per ton-mile, and with alternating current 42·5. The article is fully illustrated. A. H. A.

1188. *Accumulator Traction on the Prussian State Railways.* (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1002–1008, June 22, 1907.)—For local journeys in the neighbourhood of Mainz some 6-wheel coaches of the Berlin local service have been fitted up for accumulator traction. The average speed attained is 27 to 36 km./hour, the maximum 45 km./hour. Each coach has 6 compartments with 10 seats each. The battery consists of 180 cells of 200 amp.-hours' capacity, each cell weighing 55 kg. Two boxes together containing 15 cells are placed under each seat, the battery compartment being made tight and ventilated. The complete battery, weighing 10,000 kg., furnishes 69·5 kw.-hours, so that the specific output is 7 watt-hours per kg. of cell. The distance covered on one charge is 45–60 km. Diagrammatic illustrations are given. L. H. W.

1189. *Charing Cross, Euston, and Hampstead Railway.* (Electrician, 59. pp. 257–261, May 31, and pp. 336–339, June 14, 1907. Tram. Rly. World, 22. pp. 1–18, July 4, 1907.)—This system is the last link in the scheme of underground railways. The length of the route from Golder's Green to Charing Cross is about 5¼ miles, and the branch line to Highgate another 1¼ miles. The ventilation of the tunnels, as on the other tubes, is effected by exhaust fans capable of drawing out about 19,000 cub. ft. of air per min. The positive conductor rail is fixed outside the track on Doulton stoneware insulators, and the negative conductor rail is placed midway between the running rails on porcelain blocks. The rolling stock is exactly the same design as that used on the Great Northern, Piccadilly, and Brompton tube. The B.T.H. electrical equipment consists of four 200-h.p. motors per train, and the control is on the standard Sprague-Thomson-Houston multiple-unit system. The current for operating the tube is supplied from the Lot's Road generating station of the Underground Railway Co. at Chelsea. W. J. C.

1190. *Refuse Destructor and Electric Light Plant.* (Electrical World, pp. 50. 312–313, Aug. 17, 1907. Elect. Engin. 40. p. 292, Aug. 30, 1907. Abstract.)—The refuse destructor plant installed at the Williamsburg Bridge, New York, has been previously described [Abstract No. 288 (1906)]. It was intended to utilise the waste heat for the generation of electrical energy for lighting the bridge. This experiment has been abandoned. The refuse collected at the station was supplemented at times with coal. It was originally estimated that about £2,000 would be saved on the plant yearly. The following figures are given for the year 1906: Cost of destructor, buildings, equipment, and boilers, £12,418; cost of generating plant wires, lamps, &c., £12,061; cost of operating destructor, including repairs, supplies, coal, and interest at

4 per cent., £9,005; cost of operating electric plant, including depreciation at 5 per cent. and interest at 4 per cent., £6,284; actual saving to the street-cleaning department as compared to the cost of final disposition, £1,610; actual cost to the street-cleaning department to effect the above saving, £7,394; estimated cost of running the lighting plant with coal as fuel, £11,446. The total output in kw.-hours of energy is not given. The city engineers admit that the plant was operated at a loss, and was at all times unsatisfactory as a lighting plant. Among the reasons given is the difficulty encountered in the work of keeping up the steam in the boilers owing to the accumulation of slag, which choked the flues and ran back on the grates. The slag was caused by sand, glass, &c., in the rubbish which escaped the pickers. The quality of the fuel also caused great variations in the heat obtainable, and the necessity of opening the large feed-holes for putting large articles as sofas, barrels, boxes, &c., into the fires caused contractions which ruined the destructors. The rehandling of the rubbish also was inimical to economical operation. This was consequent upon the electric light plant being run at night, whereas the rubbish came in during the day and had to be stored in the meantime. Another reason given is, that whilst the heaviest loads on the lighting plant were in the winter, the quantity of refuse gathered was less in winter than in the summer. F. B.

1191. *Potomac Electric Power Co.'s New Plant.* **C. H. Claudy.** (Power, 27. pp. 277–282, May, 1907.)—During the past year the Potomac Electric Power Co., of Washington, has erected and is now putting into operation a new turbine power plant. The generating-room has been laid out to accommodate three 5,000-kw. and two 2,000-kw. Curtis turbines. The 5,000-kw. turbines are five-stage machines, designed to carry a load of 2,000 kw. with a vacuum in the last four stages. The station supplies power to much of the mileage of the street railways of Washington. W. J. C.

1192. *Power Development on the Kootenay River.* **R. A. Ross and H. Holgate.** (Canad. Elect. News, 17. pp. 161–168, June, 1907. Abstract of paper read before the Canadian Soc. of Civil Engineers, Montreal, May 9, 1907. Elect. Engin. 40. pp. 296–301, Aug. 30, 1907.)—The power station was built at the Upper Bonnington Falls. The general scheme is as follows: The water enters the flume through submerged openings between the piers, and can be shut off by gates. Behind the gates are screens. The water flows down the tube formed in the concrete to the wheels, of which there are three in each shaft. *Hydraulic machinery.*—Each main unit is capable of delivering to its electrical generator 8,000 h.p. when operating under a head of 70 ft. *Electrical development.*—The general scheme is so arranged that power can at present be delivered to Phœnix, 79 miles distant, at 60,000 volts; Grand Forks, 69 miles, at 60,000 volts; Greenwood, 88 miles, at 60,000 volts; Rossland, 32 miles, at 22,000 volts. The whole of the power is used for mining work, for large motor equipments, and for lighting and power in the mines. W. J. C.

1193. *Traunfall Hydro-electric Plant.* (Elektrotechnik u. Maschinenbau, 25. pp. 495–499, June 30, 1907.)—This recently-erected power plant consists of three 1,100-kw., 10,000-volt, 3-phase generators constructed by the Siemens-Schuckert works, and coupled to water-turbines running at 187 r.p.m. The frequency is 50. The 32-pole field has a diam. of 3 m. The outer diam.

of the armature casing is 4 m. The armature winding consists of 96 coils, each weighing 14·5 kg., insulated with mica and easily interchangeable. The total weight of each generator is 45,000 kg., of which 8,600 kg. represent the weight of copper. At 850 kw. the efficiencies were found to be 94 and 92·9 per cent., at power-factors of 1 and 0·8 respectively. The lightning arresters are of the horn type, with gaps 4 to 5 mm. long, and are connected to earth through water resistances. In addition to these, the two longest transmission lines are provided with horns having gaps 12 mm. long and connected directly to earth. The ring bus-bars are further connected to a water-jet arrester.

A. H.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

1194. *Single-phase* v. *Three-phase Generation for Single-phase Railways.* **A. H. Armstrong.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 1041–1046, July, 1907. Street Rly. Journ. 29. pp. 1141–1142, June 29, 1907. Écl. Électr. 52. pp. 249–250, Aug. 17, 1907.)—The author points out the disadvantages of single-phase generating plant, which has the sole merit of simplicity, and proceeds to consider various methods of distributing single-phase power derived from a three-phase source. Motor-generator substations are satisfactory but costly. Single-phase distribution from the three phases leads to serious unbalancing with a railway load, and other drawbacks. Two-phase distribution from three-phase supply, and two-phase generation, are alike subject to unbalancing. No definite choice is made. A. H. A.

1195. *Choice of Frequency for Single-phase Railway Motors.* **A. H. Armstrong.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 1047–1053, July, 1907. Street Rly. Journ. 29. pp. 1186–1188, June 29, 1907. Écl. Électr. 52. pp. 349–351, Sept. 7, 1907.)—While 15 cycles gives better commutation and higher efficiency, there is no net reduction in weight as compared with 25 cycles. The coefficient of adhesion is slightly reduced with the lower frequency, and there are difficulties in the construction of the generators. The general use of 25 cycles for power supply is a strong reason for adopting that frequency for railway working, and it is open to question whether the type of motor on behalf of which a lower frequency is advocated is so much superior to other types as to justify the departure from existing standards. A. H. A.

1196. *Service Tests on Cars operated singly and in Two-car Trains.* (Street Rly. Journ. 30. pp. 322–324, Aug. 31, 1907.)—The article is a record of some tests carried out by the Department of Electrical Engineering of the Ohio State University on some rolling stock of the Columbus Railway and Light Co. It consists chiefly of a comparison of single-car service with two-car service. In the case of the two-car service the control was by means of a master controller. The leading car used both in the single-car and train tests is specified by the following: Weight (in metric tons) of body, 9·00 tons; trucks, 2·76 tons; motors and gearing, 2·20 tons; pneumatic and electric equipment, 1·42 tons; total weight, 15·3 tons; seating capacity, 40; length over vestibules, 40 ft. 8$\frac{7}{16}$ in.; wheel diam., 33 in.; Brill maximum traction trucks; two G.E.-67 motors, 40 h.p. each and

[1] Non-electrical Automobiles are described in the Section dealing with Steam and Gas Engines.

geared 67 : 17. The trail car was similar to the leading car, except that its platforms were each 1 ft. shorter. Both cars were in ordinary operating condition, and picked at random. On the leading car power is consumed in the motor, control and air-compressor circuits; on the second car power is consumed only in the motor and air circuits. Data of the results of these tests are given in the following table :—

	Single Car.	Two-car Train.
Length of single run	6·68	6·63
Number of runs	6	6
Time of runs	From 6 a.m. to 10.36 a.m.	From 6.10 a.m. to 10.39 a.m.
Date of runs	April 6, 1907	April 5, 1907
Route	Entire length of High Street, Columbus, Ohio, U.S.A.	
Data of grades, curves, weight of track, and gauge of track	Not given	Not given
Condition of track	Dry and clean	Dry and clean
Total passengers carried per trip	79	88
Average number on car or train	31·9	30·6
Average stops per mile	7·4	8·1
Schedule speed	9 miles per hour	9 miles per hour
Average pressure (volts)	521	517
Average current (amps.)	70·8	149
Power (watts)	37,000	77,000
Average time power is on per trip	1,299 sec.	1,349 sec.
Average energy per trip	13·3 kw.-hours	28·9 kw.-hours
Average energy per car-mile	2·01 kw.-hours	2·20 kw.-hours
Average energy per ton-mile	118 watt-hours	128 watt-hours
Energy absorbed in control circuit per trip	51 watt-hours	52 watt-hours
Energy absorbed in air circuits per trip	48 watt-hours	81 watt-hours
Total energy per trip, including motor, air and control circuits	2·11 kw.-hours per car-mile, 177 watt-hours per passenger per trip	2·29 kw.-hours per car-mile, 345 watt-hours per passenger per trip

From the standpoint of energy per car-mile and per passenger, the single car has the advantage, and especially in regard to the watt-hours per passenger. The traffic conditions, however, were such that the two-car train was not worked at the same relative load, the number of passengers being about the same for both days. If there had been the same number of passengers on each car in the two-car train as there were in the single car, the results would have been quite different; instead of the watt-hours being 345, they would have been nearly halved. Obviously the two-car service should be employed only when traffic is dense enough to fill both cars, and where the headway with single-car service would be too small. Only the power consumption has been considered in this connection, and no account is taken of any differences in other operating expenses, such as labour and maintenance. A test of the control system showed that the control current taken by the master controller is about $2\frac{1}{2}$ amps. for an equipment of 400 h.p. or less. Special tests were made on the air-brake equipment which was provided by the General Electric Co. of America, and

comprised cylinders of 8 in. diam. The compressor motor took 4 amps. at 500 volts. The ratio of the brake levers was $8\frac{1}{4}$ in. to $10\frac{1}{4}$ in., the $10\frac{1}{4}$-in. end being connected to the rod from the brake cylinder. On the two-car train all the air was supplied from the reservoir of the leading car, and the trail car reservoir was cut out to be used only in emergencies. The results were not very different for the single-car and two-car service, and the data were reduced down to watt-hours per ton per stop, the average value of which was 0·85. With both services the time employed for stopping from a speed of 15 m.p.h. was about 10 sec., the deceleration thus being at the rate of 1·5 m.p.h. per sec. H. M. H.

1197. *Regenerative Control of Single-phase Railway Motors.* **W. Cooper.** (Abstracts in Amer. Inst. Elect. Engin., Proc. 26. pp. 1238–1244, Aug., 1907. Electrical World, 50. pp. 91–92, July 13, 1907. Street Rly. Journ. 29. pp. 1146–1149, June 29, 1907. Elect. Rev., N.Y. 51. pp. 180–182, July 27, 1907.)—The author employs the following method of regenerative control with single-phase railway motors. One of the motors is used as an exciter for the others. By means of suitable taps provided on the auto-transformer, the voltage impressed on the field of the exciter,—which is entirely disconnected from its armature, so that the machine becomes a separately excited one—may be varied within wide limits. The armature of the exciter supplies current to the field windings of the separately excited motors which are being used as generators, and whose armatures are connected across a suitable number of turns of the auto-transformer. The current in the field winding of the exciter will be approximately in quadrature with the impressed voltage; similarly, the current in the field windings of the generators will be nearly in quadrature with the e.m.f. of the exciter armature; but since this latter is in phase with the exciter field current, and hence in quadrature with the impressed p.d., it follows that the e.m.f.'s of the generator armatures will be in opposition of phase to the auto-transformer p.d., and will thus be capable of returning energy to the auto-transformer. The e.m.f. of the exciter armature being proportional to the speed, that of a generator armature will vary as the square of the speed. The method is characterised by safety and stability of operation; it has been used in testing locomotives over a wide range of speed, with highly satisfactory results. A. H.

1198. *Main Line Electrification.* **F. J. Sprague.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 1127–1216, July; Discussion, pp. 1298–1332, Aug., 1907. Abstracts in Street Rly. Journ. 29. pp. 907–915; Discussion, pp. 915–918, May 25, 1907. Electrician, 59. pp. 865–868, Sept. 13; 916–918, Sept. 20; 945–949, Sept. 27; 994–996, Oct. 4, and pp. 1087–1088; Discussion, pp. 1088–1099, Oct. 11, 1907.)—The author reviews the present state of the problem of railway electrification, dealing with it both from a general and a technical standpoint. He considers the increased capacity of a line as the main advantage resulting from electrification, and as of greater importance than any gain in economy of working. Hence electrification can be most confidently recommended in the case of lines characterised by great density of traffic and worked to their utmost capacity. The various types of railway motors are next briefly considered. A comparison of the continuous-current with the single-phase motor undoubtedly shows that, for equal weights, the former has an output nearly twice as great as the latter. The important improvements which have taken place in continuous-current railway motors, as exemplified by the motors on the New York Central type of locomotive

(of which there are 85 now in regular service, each of 2,200 h.p.), are briefly described. The motors are bipolar, and hence may easily be wound for high voltages. The armature is mounted solidly on the driving axle, and is *movable relatively to the field*, the latter being rigidly attached to the main frame. The air-gap is so large, and the pole-pieces so nearly flat, that a complete axle unit with its armature may be readily dropped out or replaced without disturbing the remainder of the equipment. Each locomotive is provided with 4 driving axles. In dealing with electric braking, the author attaches but little importance to the regenerative method, and prefers the self-exciting method (this latter cannot be depended upon in the case of single-phase motors) as being the more reliable of the two. Electric braking should only be regarded as supplementary to air-braking, and doing away with certain difficulties connected with the latter method when used continuously on long down-grades. Overhead and third-rail methods of construction are next reviewed, and an illustrated description is given of the Wilgus and Sprague third-rail in use on the New York Central [Abstract No. 1444 (1905)]. The author does not much favour the three-wire system, as in most cases the desired result can be attained by the use of the simpler two-wire system, using a voltage of 1,200. By adopting a particular construction (of which the details are not disclosed), it seems possible to use the under-contact rail at this voltage with perfect safety. The proposal to use a frequency of 15 instead of 25 on single-phase systems does not appear to have much to recommend it, as the lower frequency results in an increase of weight. Brief descriptions are given of the more recent types of locomotives—continuous current, single- and three-phase. A. H.

1199. *Single-phase Traction on the New York, New Haven, and Hartford Line.* (Electrical World, 50. pp. 310–312, Aug. 17, 1907. Street Rly. Journ. 30. pp. 242–245, Aug. 17, 1907.)—The reasons for the choice of the single-phase system for the working of the terminal section and approaches of the railway, on the compulsory abandonment of steam, are given. The New York Central Railroad had already adopted the third-rail system with direct current, and leased part of the line in common with the New Haven Co.; the choice lay between this system and the high-pressure, single-phase system. The former was rejected because of previous unsatisfactory experience with it, its lower efficiency and less flexibility, its greater complication, and the restrictions imposed by the use of the third rail. Further, the company had in view the extension of the electric service to other parts of the railway system. The total cost of the single-phase system will be much less than that of the other and the cost of energy delivered at the train will also be less. The frequency of 25 cycles was in use for lighting and power on the railway, and was retained on account of the cost of effecting a change to 15 cycles. The pressure of 11,000 volts adopted was the highest practicable without using transformer substations. It is considered that the change from steam to electric traction must be governed by the gain in speed and carrying capacity rather than by possible economy in working. [See also Abstract No. 691 (1907).] A. H. A.

1200. *Frequency for Heavy Railway Traction.* **N. W. Storer.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 1055–1068, July, 1907. Street Rly. Journ. 29. pp. 1138–1140, June 29, 1907.)—The author discusses the advantages claimed respectively for 25 and for 15 cycles for single-phase electric

railways, in favour of the latter. He shows that the enormous importance of railway electrification justifies a departure from existing standards, and that as the fluctuation of voltage on a railway system renders the supply unsuitable for lighting and power except through a motor-generator, the choice of frequency does not affect this question. Transformers are heavier for the lower frequency, but the strong argument for the latter is the great saving in the weight of the motors (30 to 40 per cent.), which is illustrated with practical examples. This advantage will be felt especially when locomotives are employed. A description is given of a 2,000-h.p. locomotive built for 15 cycles, to haul a train weighing 400 tons. With 25 cycles the cost of the equipment would be 50 per cent. greater. The locomotive weighs 140 tons, and is equipped with four motors. The saving in power generated for a single-phase railway would be from 5 to 15 per cent. if 15-cycle motors were used. A. H. A.

1201. *Notes on Tramway Wear and Maintenance.* C. F. Wike. (Tram. Rly. World, 22. pp. 28–30, July 4, 1907. Paper read before the Assoc. of Municipal and County Engineers at Liverpool, June 20–22, 1907.)—In this article the specification of the Sheffield tramways is given together with a few other particulars, as since this system was last dealt with a second contract has been carried out. *Specification Rails.*—British Standard Section No. 5, length 60 ft., weight 110 lbs., per yard. The analysis of the rails supplied under first and second contract are given below:—

	First Contract.	Present Contract.
Carbon	0·35 to 0·45 per cent.	0·40 to 0·50 per cent.
Silicon	Not more than 0·1 „	Not more than 0·1 „
Sulphur	„ „ 0·1 „	„ „ 0·08 „
Arsenic	—	„ „ 0·08 „
Phosphorus	„ „ 0·06 „	„ „ 0·06 „
Copper	—	„ „ 0·08 „
Manganese	—	Not less than 0·70, and not more than 1·10 per cent.
	No other material present except iron and manganese.	

Joints.—The standard specification also applies to the fishplates. Each joint is secured with six pairs of nuts and bolts, and Ibbotson's lock nuts are used. Cross anchors are also used at 20-ft. intervals. The bonds are of the Crown solid type. *Points and Crossings.*—These are all now of manganese steel. The points are on the twin movable principle and are 12 ft. long. *Concrete.*—The rails are laid and jointed before the concrete is laid. The proportions used are six of broken stone and sand to one of Portland cement. The question of general cost of repairs and renewals is then dealt with, and tables are given showing the cost for each year since the lines were opened, and figures are also given as to renewals. The tendency is to make the new work more substantial; but, on the other hand, the frequency of the car traffic steadily increases and heavier cars are being used, so that the annual wear and tear is greater. Touching on the point of corrugation, this trouble has not been so pronounced in Sheffield as in some other towns. The most hopeful method of treatment seems to be to attach grinding blocks to a car. C. E. A.

1202. *Report of the German Street and Interurban Railway Association's Committee on Standardisation.* (Street Rly. Journ. 30. pp. 353–356, Sept. 7, 1907.)—This article contains a detailed *résumé* of the report of the German Street and Interurban Railway Association's Committee on Standardisation of Rolling Stock. A previous report covered the subject of rail specifications [see Abstract No. 444 (1907)]. The present report deals with axles, trucks, curves, gears, brakes, and details connected therewith. Data are given of the weight per seat and of the average seating capacity of single- and double-truck cars. The following standard axles are recommended:—

Axle diam.	100	105	110	120 mm.
Journal diam.	75	80	80	90 „
Journal length	150	180	210	250 „

The journal pressure allowed by most companies is given as 20 kg. per cm.². Particulars of wheel bases and curves are given, from which it is concluded that the maximum practicable wheel base is 2 m. for curves of 16 to 18 m. radius. Single-axle running gear has been tried by nine railways, four of which report favourably and only one reports insufficiency of braking. The remainder of the report deals with motor bearings, lubrication, and the life of brake-shoes and gearing. A. G. E.

1203. *A Discussion of Train Resistance.* (Eng. Record, 55. pp. 618–621, May 25, 1907.)—In a preliminary report presented at the last convention of the Maintenance of Way Association, the Committee of the Economics of Railway Location summarises the data it has collected in connection with the various formulæ for train resistance, and discusses them in a general way. It is pointed out that train resistance is composed of three parts: Resistance on a level tangent; resistance due to grade; resistance due to curves. The resistance on a level tangent has been the subject of numerous experiments, but the committee concluded that these have failed to present the degree of uniformity desirable. The resistance due to grade is capable of being stated by the formula $r = 20g$, where r is the resistance due to grade and g is the grade in feet rise per cent. Curve resistance is about 0·8 lb. per ton per degree of central angle or 0·04 for compensation per degree. The resistance of a level tangent is made up of the rolling friction between the wheel and the rail, the journal friction between the journal and bearing, the atmospheric resistance by the head, tail, and sides of the train, and oscillation and concussion. Not much is known of any one of these in itself, and consequently it is not strange that the knowledge of their compound effects on the train is less satisfactory than desirable. It is known that journal friction decreases with speed up to a certain limit, and the atmospheric resistance increases with an increase of speed, possibly as the square of speed. Little is known about rolling friction, and still less about oscillation and concussion. In conclusion the committee makes the following recommendations: (1) That each company conduct its own experiments for train resistance. (2) For the present for such experiments the dynamometer method shall be used, and the resistance of train alone determined. (3) That the determination of the amount of pull available at the draw-bar at various speeds for locomotives of the different classes be left to the proper motive-power officials. (4) That speeds be determined as closely as 0·1 mile per hour. (5) That for experiments on heavy freight trains at low speeds the formula should have the form $r = a + bV$. (6) That an additional term

be added to show the effect of loading. (7) That all tests for train resistance should be made on tangents. (8) That for determining the sum allowable to save curvature, or to save rise and fall, the average line for train resistance should be used. (9) That for grade revision, for questions of momentum grade, a maximum line above the average train resistance should be used—a line somewhat near the outer edge of the experimental results plotted in a diagram. C. E. A.

1204. *Corrugation of Tramway Rails.* W. W. Beaumont. (Elect. Engineering, 2. pp. 227–228; Discussion, p. 228, Aug. 8, 1907. Paper read before the British Assoc. at Leicester. Elect. Engin. 40. pp. 191–192; Discussion, pp. 192–193, Aug. 9, 1907. Electrician, 59. p. 798, Aug. 30, 1907.)—The author in opening his paper gives a description of the so-called "corrugation." It consists, in fact, of an approximately regular alternation of hard and soft, or of hard and less hard, patches of the surface rolled by the tramcar wheels. The surface of the hard patches is very slightly higher than the general surface, but it becomes sufficiently so to declare its existence by the noise made by the tramcar wheels. Corrugation declares itself variously as to time of its appearance after a rail is first used, position of rail, and somewhat differently in different towns, but it has become general since the introduction of electrically propelled tramcars. The author offers the following as an explanation of the origin and production of corrugation: 1. The compression of the material of the tread of the rail by the tramcar wheels: cold rolling. 2. The microscopic deformation of the surface of the rail on the small area of contact between wheel and rail, that deformation being attended by a depression under the wheel. 3. That the material of the surface in front of the wheel and the depression recurrently forms a slight ridge, over which the wheel mounts. 4. That the area of contact between wheel and ridge is minute, and the pressure, therefore, very great per unit of area. 5. That the distance between each ridge thus formed by the rolling wheel will vary slightly with the strength, hardness, and toughness of the rail, and with the speed of the car wheels. 6. That the originating ridge forming the incipient hard patch is added to on the formative or rear side. 7. That the hard patch thus formed for a time resists the destructive deformation by the wheel, but that it increases the rate of local side detrusion. 8. That a steel rail loses a large part, if not most, of its weight in wear by the separation of the compressed and crushed surface by minute exfoliation. 9. That this disintegration of the surface partially relieves the surface film of the destructively compressed parts and the sub-surface of the corresponding tension. 10. That the hard, bright patches depend for their duration upon the strength of their supporting materials, and in many cases should disappear, though they reappear in different position. 11. That the appearance of the hard patches on the outer curves of some lines where none appear on other of the rails of the same line is due to the heeling over of the cars on the curve and the extra weight thereby put on the outer wheels. 12. That it is possible that the final passes of some rails through the rolls at a comparatively low temperature may produce a condition in the rail conducive to initiation of corrugation. 13. That there are numerous circumstances and conditions in the working life of a tramway rail which produce great contrariety in results, including (*a*) its correct laying, (*b*) the speed of the cars, (*c*) the character of the dirt and grit on the rails, the constitution of the rail, &c. The remedy appears to be the use of lighter cars, harder rails, and moderate speeds. In the *discussion*, R. E. Crompton thought it was very difficult to assign one

definite cause to the phenomenon of rail corrugation. **S. P. Thompson** said they must look for a periodic cause to explain a periodic effect. He suggested that the period of the corrugations was probably that of the free swing of the twisted axle, and likened the effect to the action of a bow on a violin string. C. E. A.

1205. *Standardisation of Street Railways Details.* (Street Rly. Journ. 30. pp. 225–228, Aug. 10, 1907. Account of Meeting of the Committee on Standards of the Amer. Street and Interurban Railway Engin. Assoc., July 26 and 27, 1907.)—The standardisation of axles, journals, bearings, and journal boxes, brake shoes, brake shoe heads and keys, sections of treads and flanges of wheels, was discussed. In no case were any specifications finally adopted, but the following five axles were to be submitted to manufacturers:—

Motor, h.p.	25–40	45–65	70–100	105–150	155–225
Lining, inches.........	4½	5	5½	6	6½
Gear pit, inches	5½	6	6½	7	7½
Between hubs, inches	48	48	48	50	50

The *discussion* on journal boxes referred chiefly to the space required on the axle, the shape of the top of box, and the space between the guides. **Sargent** gave drawings of three proposed standard brake shoes for different treads, and **Thompson** stated that the Central Railway has evolved a single standard. **P. H. Griffin** considered the length of hub the most serious question at the present day in electric railway practice. He also proposed an increased thickness of flange, and submitted a section of a wheel which he considered desirable. Drawings are given by the committee showing simultaneously a large number of different companies' wheel sections. F. R.

1206. *Straightening of Rails in the Cold and Hot States.* **S. v. Schukowski.** (Stahl u. Eisen, 27. pp. 797–800, June 5, 1907.)—It is well known that cold straightening not only severely strains the metal of a rail, but also leaves the rail as a whole in a condition of internal stress. The author has observed the gradual curving of rails during cooling, and gives a series of photographs following the behaviour of five rails. He proposes to give a slight amount of set to the rail in the contrary direction to that in which it sets upon cooling, and of suitable amount, as it leaves the last pass. This will result in reducing the amount of cold straightening required to a minimum. F. R.

1207. *Brake-shoe Testing: Report of Committee of the Master Car Builders' Association.* (Eng. News, 58. p. 16, July 4, 1907.)—At a meeting of the above committee in the latter part of last year it was decided to revise the testing machine and to devote the entire work of experimentation during the current year to the study of the wearing qualities of brake shoes. Hitherto the study of frictional qualities has been the sole basis of investigation, now wearing tests are to be made in addition. By careful study it was found that a suitable attachment could be devised, and the purpose of the proposed addition was as follows: To permit the shoe to be brought into contact with the wheel of the testing machine for a predetermined interval, after which it would be automatically released, remaining in release position for another and much longer interval, during which time both wheel and shoe would return to their normal temperature. It was believed that by such a

cycle any shoe could be given a definite amount of exposure to wear; that the comparatively short interval during the application and a much longer one during the release would avoid all chances of excessive heating; and that by its automatic action the motion of the machine would continue hour after hour, with but little attention from the laboratory attendants. Accessory to the large machine there would be, of course, required a registering counter to show the number of applications, and a delicate balance for weighing the shoes before and after they are exposed to the action of the machine. The committee selected 15 shoes on which the regular frictional tests had been made in 1906 and used these shoes for the wearing tests of this year. The machine was set under the control of a gear which required 800 revs. for a complete cycle, during 190 of which the shoe was in contact with the wheel. It was found that by employing a speed of 20 miles per hour and a brake-shoe pressure during application of 2,808 lbs. the machine could be kept in continuous motion under the cycle without undue heating either of the wheel or shoe. The severity of test conditions may be judged from the fact that the work done by the brake shoe during each application is approximately the same as that which would be done by each of the eight shoes of a loaded 100,000 lbs.' capacity car in bringing the car to rest on a level track from a speed of 40 miles an hour. The accompanying table shows the results of

WEAR OF BRAKE SHOES ON CAST-IRON WHEELS—SPEED CONSTANT AT 20 MILES PER HOUR; PRESSURE OF SHOE ON WHEEL, 2,808 LBS.; REVOLUTIONS OF WHEEL DURING APPLICATION, 190; EQUIVALENT DISTANCE RUN DURING APPLICATION, 1,641·5 FT.

Number of Shoe.	Coefficient of Friction.	Weight of Shoe, lbs.	Number of Applications.	Total loss of Weight, lb.	Loss of Weight per Application, lb.	1,000,000 ft.-lbs. of work Absorbed per Application.	1,000,000 ft.-lbs. of work Absorbed per pound of Material Lost.
158	22·5	22·046	90	0·229	0·002544	1·086	407·2
161	21·8	21·208	94	0·644	0·006850	1·004	146·6
163	21·7	19·964	118	0·337	0·002856	1·000	350·1
172	22·8	17·180	90	0·366	0·004066	1·050	258·2
175	30·3	11·202	40	0·690	0·017250	1·395	80·8
178	20·0	18·662	90	0·364	0·004044	0·921	227·7
179	36·8	9·298	40	0·593	0·014825	1·695	114·3
183	38·7	7·846	60	0·615	0·010250	1·782	173·8
186	24·1	18·778	90	0·615	0·006833	1·110	162·5
194	26·5	22·780	90	0·198	0·002200	1·220	554·6
200	22·7	15·780	90	0·243	0·002700	1·045	387·0
205	23·5	17·610	90	1·058	0·011755	1·082	92·0
209	24·7	16·818	90	0·593	0·006588	1·187	172·0
215	20·9	16·354	90	0·320	0·003555	0·968	270·9
220	26·5	18·066	91	0·220	0·002417	1·220	504·7

these tests. In future tests the committee intends to measure the wear and tear on the wheel used in the testing, a factor not heretofore studied. [See also Abstract No. 118 (1906).]

C. E. A.

ELECTRIC LAMPS AND LIGHTING.

1208. *Davy Inclined-Carbon Gravity Feed Arc Lamp.* (Elect. Engineering, 2. p. 167, Aug. 1, 1907. Brit. Pat. 14,809 of 1906.)—In this lamp air enters the globe through a restricted annular space formed between the interior of the neck of the globe and an annular disc arranged around the block of insulating refractory material through which the carbons pass. By this means air can only slowly drift towards the carbons to feed the burning points, the rarefied air above the points being kept in a stagnant condition, so that the carbons are prevented from being attacked above the burning points. The carbons rest at their lower ends against stops of metal or refractory material which extend obliquely into the path of the carbons. These stops are mounted in tubes, out of which they are pressed by springs, so that they can be pressed in to permit the insertion of the carbons into their guide tubes. The article is illustrated. C. K. F.

1209. *British Thomson-Houston Twin-Carbon Arc Lamp.* (Elect. Engineering, 2. p. 258, Aug. 15, 1907.)—In this lamp, which burns for 100 hours on 200–250-volt circuits at from 2·75–3·5 amps., there are two arcs in series with each other and with an outside resistance of non-expansive wire wound on a grooved porcelain drum. The magnet is wound with enamelled wire. There is very little technical description of the lamp, but there are two good sectional elevations and two photographs. C. K. F.

1210. *Elements of Inefficiency in Diffused Lighting Systems.* **P. S. Millar.** (West. Electn. 41. p. 111, Aug. 10, 1907. Abstract of paper read before the Illuminating Engin. Soc., Boston, July 30, 1907.)—Results of comparative trials of diffused and direct lighting systems are given, and it is shown that if the horizontal plane is made the sole criterion, the efficiency of the diffused lighting to the direct averages about 80 per cent. This low efficiency is accounted for by (1) losses in multiple diffuse reflection, (2) necessity of providing everywhere on the working plane an illumination equal to the highest required at any point, (3) ineffectiveness of rays falling at a small inclination on the surface to be illuminated, (4) craving of the eye for higher intensities when surrounding objects are brilliantly illuminated. As a result of trials with 10 persons, 65 per cent. higher intensity of illumination was found to be required for reading with diffuse light than with direct. In diffuse lighting, brilliant illumination is produced where it is useless and undesirable, and conditions are established which create a demand for an unduly high intensity on objects viewed. H. F. H.

1211. *Illuminating Engineering.* **C. H. Sharp.** (Elect. Rev., N.Y. 51. pp. 200–203, Aug. 10, 1907. Presidential Address to the Illuminating Engin. Soc., Boston, July 30, 1907. Electrician, 59. pp. 801–802, Aug. 30, 1907. Abstract. Elect. Engin. 40. pp. 886–889, Sept. 6, 1907.)—The address discusses the concepts and terminology of illuminating engineering. Its purpose is to point out the utility of certain ideas and names which should prove useful in the art. The *lux* is the illumination produced by 1 candle at the distance of 1 m. It equals 10·8 candle-ft. This unit is found awkward in practice as it involves the use of an unfamiliar standard of length. There is no reason, however, why the *lumen*—the flux emitted by a source of 1 c.p. through unit solid angle—should not be immediately adopted. The superiority of "lumens per watt" to "foot-candles per watt per square foot" is at once evident. A. R.

1212. *Colour Phenomenon in Photometry.* L. W. Wild, J. S. Dow. (Electrician, 59. pp. 729–730, Aug. 16; Correspondence, p. 766, Aug. 23, 1907.) —J. S. Dow [see Abstract No. 1560A (1906)], when comparing a gas mantle against a Methven screen by a flicker photometer, found that altering the distance of the eye from the screen from 20 to 60 cm. alters the reading obtained by 8 per cent. The author has carried out similar experiments on his own form of flicker photometer [see Abstract No. 992B (1906)]. In no case does the variation from the mean reading amount to as much as the half of 1 per cent. The photometer was arranged so that it could be used with different sized diaphragms, with a telescope, or a single lens eyepiece or without any lens at all. He first tried ½ and 1 in, diaphragms with the eye 6 in. and 2 feet from the photometer screen. He then tried the effects of a single lens eyepiece and a telescope. The conclusion is that with this type of photometer the size of the field of view and its distance from the eye has no effect on the readings, at least when the colour of the lights to be compared does not differ by more than the difference in the colour of a pentane flame and a gas mantle. He also concludes that the inclined screens in the photometer used by Dow were the cause of the effect. A. R.

1213. *Photometric Luxmeter.* A. Blondel. (Rev. Électrique, 8. pp. 91–92, Aug. 15, 1907. Paper read before the Assoc. franç. pour l'avancement des Sciences, at Rheims, 1907.)—The author states that this new instrument belongs to the "cat's eye" type of photometer. The illuminations are produced on the screen by discs of a diffusing substance, the light falling on which can be varied by means of suitable apparatus. The new method employed is to use a very small screen made up of three small prisms combined with a powerful magnifying system of two lenses which concentrates all the light on the eye in a similar way to that employed in the Cornu microphotometer. As the lengths of the sides of the prisms are only from 5 to 10 mm. a symmetrical apparatus can be employed. The prisms are placed at the centre of a tube at the ends of which are the two diffusing discs. The prisms are arranged very simply so as to form an excellent contrast photometer, various arrangements being shown. The three conditions which this photometer has to satisfy are: (1) the image of the diffuser must be less than the pupil of the eye; (2) all the rays leaving the prisms must fall on the frontal lens; (3) the distance of the focus of the optical apparatus must be sufficient to give a clear image of the screen. These conditions are sufficiently well satisfied by a double lens magnifying 20 times in combination with diffusing screens 35 mm. in diam. at a distance of 18 cm. from the screen. The cat's eye is composed of two shutters which move in opposite directions before a rectangular diaphragm. The sensibility of the apparatus is practically constant, since the area exposed is proportional to the distance between the shutters. A mirror fixed at the end of the tube allows rays coming at any angle to be photometered. The photometer may be used either in the laboratory or for measuring street lighting. In the latter case a straight filament lamp of small voltage is employed as the light-standard. The apparatus is specially adapted for use out-of-doors. Being made of aluminium it is very light and its small size is a great convenience. A. R.

1214. *Observations on Metallic Lamp-filaments.* R. Jahoda. (Elektrotechn. Zeitschr. 28. p. 846, Aug. 22, 1907.)—The author in this letter calls attention to the fact that in many metallic filament lamps even the thinnest

[squirted ?] filaments are hollow, not merely when formed, but even the crude filaments. A method of mounting sections of such filaments for microscopical examination is described. The explanation volunteered is that the squirted filaments harden from the external surface inwards, so that any contraction would bring the mass closer to this surface and thus a central canal be gradually formed. The chief importance of this observation lies in the fact that in general the external diameter is used as a basis for the determination of the specific resistance of the filament. L. H. W.

1215. *Improvements in the Treatment of Metallic Tantalum.* (Brit. Pats. 14,062 and 22,491 of 1906.)—These two patents of Siemens and Halske (v. Pirani) relate to the manufacture and treatment of tantalum specially for use in glow-lamps. The first patent concerns a process for the production of pure and ductile Ta from the easily obtained and brittle Ta containing hydrogen which is produced by heating a mixture of tantalum chloride vapour and hydrogen. It consists in heating the Ta containing hydrogen above its melting-point in a vacuum and removing the separate gases by means of the air pump. The resulting metal is very ductile. In the second patent the production of homogeneous masses of Ta (and other difficultly fusible metals in the powdered form) by means of focussing kathode rays on the Ta specimen connected to the anode of an exhausted vessel is described. The British Thomson-Houston Co. (from the Gen. Electric Co., U.S.A.) describes a process (No. 21,511 of 1906) by means of which the tantalum can be given a much higher resistivity, with the corresponding advantage that a much shorter length of wire, or a wire of larger section, can be employed for the same voltage than previously. The process consists in heating the filament or wire of pure Ta for a short time in an atmosphere of nitrogen at 15 mm. pressure. It is supposed that a tantalum nitride is formed, but the practical result is that a filament having a resistance of 65 ohms cold before treatment acquired a resistance of 240 ohms when cold after treatment, and could be run at a brilliancy equal to that of the ordinary Ta filament.

L. H. W.

REFERENCES.

1216. *Extra High-tension Switch Gear.* (Engineering, 83. pp. 405–406 and 420, March 29; 444, 445, and 447–448, April 5; 511–513, April 19; 576–578, with Plate, May 3, and pp. 676–677 and 678, May 24, 1907.)—An illustrated serial describing in detail examples of modern distance control switchgear made and erected by Ferranti, Ltd., for Glasgow Corporation, Durham Collieries Electric Power Supply Co., and North Metropolitan Electric Power Supply Co. W. E. W.

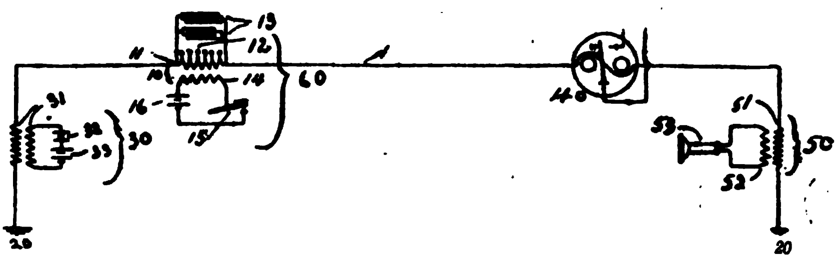
1217. *Alternating Current-Direct Current Air-brake Apparatus.* (Elect. Rev., N.Y. 51. pp. 302–304, Aug. 24, 1907.)—Manufactured by the National Brake and Electric Co., of Milwaukee, for use on single-phase railways where direct current operation is also employed. Illustrated.

1218. *Recording Machine for Dynamometer Tests on Railway Trains.* (Eng. News, 57. pp. 615–617, June 6, 1907. Paper read before the St. Louis Rly. Club.)—This article gives a description of a dynamometer test-car, and from examination of a chart which is reproduced, showing the record of a run on the Missouri-Pacific Railway, it will be seen that the apparatus is capable of making a number of records connected with train-running, comprising resistance, speed, time, distance, steam pressure, amount of coal fired, water used, brake applications, and curvature of the line. C. E. A.

TELEGRAPHY AND TELEPHONY.

1219. *Kotyra Keyboard Wheatstone Perforator.* (Elect. Rev. 61. pp. 248–249, Aug. 16, 1907.)—The apparatus consists of two essential parts—namely, three electromagnets and a keyboard. This combination can be used in conjunction with an ordinary perforator or with a pneumatic puncher, the electromagnets being so applied to the plungers that, when actuated by the keyboard, they perform the work known as punching, at present done by hand or by air pressure. The mechanism is diagrammatically explained. A large number of multiple slips are readily obtainable. E. O. W.

1220. *Simultaneous Transmission of Telegraphic and Telephonic Impulses.* (West. Electn. 41. p. 141, Aug. 24, 1907.)—When telegraphing is done by the ordinary direct current no difficulty is encountered in arranging condensers and impedance coils to smooth out the telegraphic impulses and make the rise of the current so gradual that no sound is heard in a telephone receiver. Thus a path may be established for the telephonic impulses, opaque or nearly so to the impulses due to the make and break of a direct current. For such purpose different arrangements have been devised and are more or less successful. But when the telegraphic impulses



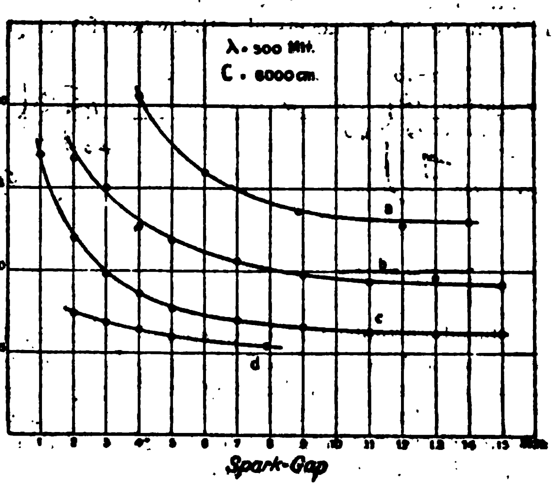
are due to induced currents, that is, when the secondary impulses of an induction coil are sent over a line, these impulses are retarded by the impedance coils just as well as the telephonic impulses, and electrostatic devices—such as condensers—are just as transparent to the flow of such impulses as to telephone currents. Such arrangements, therefore, as shunting the telephonic receiver with condensers or trying to provide an alternative path for the telegraphic induced impulses with the aid of coils opaque to telephonic impulses, are out of the question. For telegraphing with induced currents (generated in the secondary of an induction coil by interrupting the primary current), I. Kitsee devised the arrangement shown in the Fig. The secondary coil is shunted by a condenser of capacity about 5 mfd. The secondary can be varied in resistance from 6 to about 200 ohms. The best result is obtained by connecting the different coils of this secondary (of the telegraphic transmitter) in multiple so as to give a combined resistance of 12 ohms. E. O. W.

1221. *Vyle's Telegraphic Sounder.* (Electrician, 59. pp. 802–803, Aug. 30, 1907.)—This describes a new form of polarised sounder which overcomes the acoustic defects of the old form and which can be placed directly in the line circuit without any relay or local battery being

necessary. It is said to give firm readable signals, with a current of 4 milliamps., identical in sound with that of the ordinary type of pony sounder, which it resembles in appearance. The winding is differential, each coil being of a resistance of 500 ohms. Thus it can be used for simplex or for duplex working. The inventor is C. C. Vyle. In view of the fact that the Vyle sounder can be worked through condensers, the instrument becomes especially valuable in preventing disturbances due to the leakage of currents or magnetic storms. The sounder has also been designed to possess a high inductance, which renders it insensible to inductive disturbances, whether electrostatic or electromagnetic. The new sounder is now working (direct-reading) duplex on the London-Glasgow cables—*i.e.*, over 400 miles of underground work. When the sounder is adjusted no effect whatever is produced by extraneous inductive disturbance. The figure of merit of the Vyle sounder is 1 milliamp.

E. O. W.

1222. *Damping in Spark-gaps of Wireless Telegraph Circuits.* **H. R. v. Traubenberg** and **W. Hahnemann.** (Phys. Zeitschr. 8. pp. 498-505, Aug. 1, 1907.)—The experiments were carried out in conjunction with H. Lange, and relate to investigations of the damping in undivided (single)



spark-gaps, and also in multiple spark-gaps. The method adopted was similar to that used by Rempp, but the capacities were larger (resultant capacity 15,000 cm. in all cases). The curve connecting decrement with spark-length is similar to that of Rempp, but since a great part of the damping might be due to losses in the condensers, the measurements were repeated with the condensers grouped so as to be loaded to a less degree (jars of 10,000 cm. each, 4 series groups of 6 in parallel). The curve obtained with this arrangement shows no pronounced minimum, but has a nearly straight portion (almost constant damping) extending from 10 to 45 mm. spark-length. From these curves others are obtained showing the dependence of the damping due to the condensers and of that due to the spark alone. The results obtained with multiple gaps are in agreement with those of Eickhoff [Abstract No. 1111 (1907)], the damping being the greater the larger the number of subdivisions in the gap. Thus with a wave-length of 720 m. and 2 gaps

of 10 mm. each the decrement was 0·14; with 8 gaps of 6 mm. 0·16. With a wave-length of 820 m. the corresponding figures were 0·16 and 0·19. The Gesell f. drahtlose Telegraphie have in consequence abandoned the use of the multiple gap, and instead reduce the loading of the condensers. Finally, the damping due to the spark in different gases is examined. The circuit employed had a wave-length of 500 m. and a capacity of 8,000 cm.; the condenser losses were reduced by immersing the plates in oil (condenser damping about 0·02 to 0·08). The results are shown in the curves of the Fig., where *a* indicates spark in hydrogen, *b* in coal gas, *c* in air at atmospheric pressure, and *d* in air at 1 atm. above atmospheric. The damping is thus considerably greater when the spark takes place in hydrogen or coal gas.

L. H. W.

1223. *Tuning Device for Wireless Telegraph Receiving Stations.* **E. Ducretet.** (Comptes Rendus, 145. pp. 171–172, July 16, 1907.)—The author describes a very compact and simple form of receiving jigger, comprising the usual variable primary and secondary windings and adjustable coupling. The windings are of the author's flat spiral form, and the taps are brought out to switches of the contact-stud type. The condenser is also adjustable but is not described. L. H. W.

1224. *The Poulsen Arc.* **J. A. Fleming.** (Phil. Mag. 14. pp. 254–265, Aug., 1907. Paper read before the Physical Soc., June 14, 1907. Electrician, 59. pp. 914–916, Sept. 20, 1907. Abstract.)—Besides the method of examining the Poulsen arc by means of a neon tube [see Abstract No. 840 (1907)], another proof of the fact that the oscillating circuit is not continuously excited by the arc was obtained by using a rectifying valve and telephone, when a harsh noise was heard in the latter, proving that the oscillations were intermittent. From an equation given by Hertz the author deduces the interesting result that the power, in watts, radiated from a linear antenna of any length in which a uniform alternating current is flowing is $W = 64A^2$, where A is the maximum value of the current at the base of the antenna. If (A) is the current as read on a hot-wire instrument, $(A) = A/\sqrt{2}$ and therefore $W = 128\,(A)^2$ watts. Thus with an R.M.S. current of 1 amp. the radiation would be 128 watts, and for any given current is quite independent of the height of antenna or the frequency. J. E.-M.

1225. *Universal Measuring Instrument for High-frequency Currents.* **E. Nesper.** (Elektrotechn. Zeitschr. 28. pp. 849–852, Aug. 29, and pp. 872–875, Sept. 5, 1907. Jahrbuch d. Drahtlosen Telegraphie, 1. 1. pp. 112–128, Oct. 8, 1907.)—A very fully illustrated description of the construction and uses of a testing and measuring set designed by W. Hahnemann, for use with electrical oscillations in wireless telegraph work. The chief parts consist of a wavemeter which is very similar to that of Dönitz, but with helium tube and hot-wire ammeter as indicators. The set can be used (1) as calibrated resonator for measurements of wave-length, damping, coupling, and the taking of resonance curves; (2) as calibrated oscillator with an arc generator for undamped oscillations; (3) as oscillator with arrangement for producing slightly-damped oscillations—for testing detectors, &c.; (4) as oscillator with spark-gap for production of stronger, damped oscillations; (5) as receiver for damped, and (6) undamped oscillations; (7) as a device for measurement of capacities, self-inductances, &c. Examples of some of these measurements are given. L. H. W.

1226. *New Form of Cable Head for Telephone Cables.* **H. Schultz.** (Elektrotechn. Zeitschr. 28. pp. 854–856, Aug. 29, 1907.)—Fig. 1 shows the box when closed and when opened, and is explanatory in itself. A new type of pot-head is also described, and is illustrated in Fig. 2. In this only a small quantity, comparatively speaking, of compound is used—at the top and

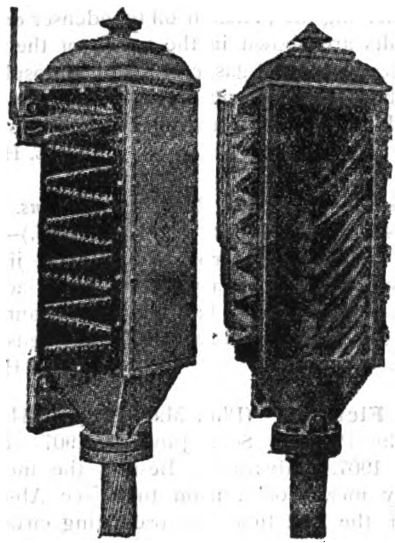


FIG. 1.

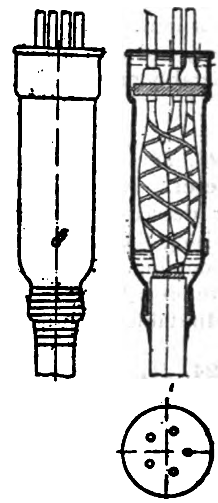


FIG. 2.

the bottom of the sleeve—plug-hole *a* permitting of the injection of the compound into the lower cavity. Cables to the distributing board are insulated with two strips of non-absorbent paper, and lightly lead-covered, in 50 pairs. This is found to be more economical than previous methods.
E. O. W.

1227. *Atmospheric Absorption of Wireless Telegraph Signals.* **R. A. Fessenden.** (Nature, 76. p. 444, Aug. 29, 1907. Elect. Rev. 61. p. 370, Sept. 6, 1907.)—In this letter the author states that the use of a longer wave-length greatly reduces the absorption due to daylight [see Abstract No. 971 (1907)]. Thus with an alternator giving 250 sparks per sec. and generating feebly-damped waves, the frequencies used being 200,000 and 81,700 per sec., there is almost no daylight absorption at the lower frequency, although such absorption is very great at 200,000 per sec. It is hence considered that the masses of ionised air which produce the absorption are broken up somewhat as clouds are, and are not continuous as has generally been supposed. It has also been found that the absorption at night-time varies with the direction from which the waves are received; and the possible application of this property to the obtaining of meteorological forecasts is suggested.
L. H. W.

REFERENCE.

1228. *Wireless Telephony.* **C. Tissot.** (Rev. Électrique, 8. pp. 73–74, Aug. 15, 1907. Paper read before the Assoc. franç pour l'avancement des Sciences, at Rheims.)—A brief *exposé* of the principles hitherto made use of. L. H. W.

SCIENCE ABSTRACTS.

Section B.—ELECTRICAL ENGINEERING.

NOVEMBER 1907.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

1229. *Modern Electricity Generating Stations and Superheat.* **O. H. Wildt.** (Ind. Élect. 16. pp. 398–400, Sept. 10, and pp. 424–428, Sept. 25, 1907.)—In this long paper the author discusses several practical conditions which affect the employment of superheated steam for use in turbines, and the arrangement of the apparatus. The most important of these are as follows: (1) In order to realise the best economy with superheated steam, turbines should be studied with a view to their being made capable of working at temperatures above 350° C.; (2) the output from a good boiler should not be improved by the addition of a superheater; (3) superheat is not obtained for nothing, whatever arrangement of superheater may be chosen; (4) the temperature of superheat should be capable of being regulated at will, so that it can be increased with diminution of load, in order to preserve a constant temperature at the stop-valve; (5) the space required for a boiler with attached superheater should be greater than for a boiler alone, for a given weight of steam, but the difference in total space between attached and independent superheaters for a battery of given size is not great; (6) superheaters without means of regulation are dangerous and often useless; (7) the length of steam pipes between superheaters and turbines should be reduced as much as possible to avoid loss due to radiation; (8) independently fired superheaters are best, being more economical, easily managed, and very durable, while their consumption of fuel is compensated by reduced consumption in the boilers. F. J. R.

1230. *Influence of Superheat on the Working of Steam Engines.* **Olry** and **Bonet.** (Rev. Électrique, 8. pp. 198–199, Oct. 15, 1907. Revue Industrielle, 38. pp. 398–399, Oct. 5, 1907. Paper read before the Assoc. des Propriétaires d'appareils à vapeur du Nord de la France.)—Various tests carried out on single cylinder horizontal condensing, and vertical compound condensing engines, with different kinds of boilers, have led to the general conclusions that the conditions which show most clearly the advantages of superheating are—high temperature of superheat, high speed of engine, presence of

passages having considerable area, absence of steam jackets and boilers subject to priming. It is suggested that superheaters may with advantage be added to installations when it becomes necessary to force the boilers.
F. J. R.

1231. *Recke-Ruston Positive Valve Gear.* (Engineering, 84. p. 437, Sept. 27, 1907.)—This gear is illustrated in a two-page engraving showing it applied to a two-cylinder tandem horizontal compound steam engine, built by Ruston, Proctor and Co., Ltd., and by several sections showing details of the gear. The engine is of the condensing type, with cylinders of 11½ in. and 17½ in. diam. and 26 in. stroke. The valve gear dispenses with some of the less popular features of the ordinary trip gear. The lay-shaft, driven by bevel-gearing from the main shaft, carries two eccentrics for each cylinder—one for admission and one for exhaust. Each eccentric-rod operates a rocking shaft working in bearings in the valve-spindle guide-castings, and carrying at each extremity a cam or curved lever which engages with a hook-shaped link on the valve spindle. These two contact pieces are so arranged that their point of rolling contact is always in the vertical through the valve. The valves are opened and closed without shock, a clearance of not more than 2/1000 in. being allowed when the valve is hard down on its seat. Backlash is avoided and wear is reduced by abolishing hammering action. Control is positive, cut-off is controlled by a governor on the lay-shaft, giving a range of from 0 to 65 per cent. of the stroke. The engine shown is designed for a working pressure of up to 160 lbs. per sq. in. and a speed of 150 to 160 r.p.m., the max. i.h.p. being 222. F. J. R.

1232. *New Anti-friction Metal.* **L. Sempell.** (Metallurgie, 4. pp. 667–670, Oct. 8, 1907. Communication from the Inst. f. Metallhüttenw. u. Elektrometall. d. Kgl. techn. Hochschule, Aachen.)—Gives a comparison of a well-known bearing metal with an aluminium copper alloy, with the results shown in the following table :—

Percentage Composition of Alloy.	Melting-point.	Depth of Impression in Hardness Test, mm.	Amount ground away by 1 hour's rubbing, gm.	Relative Cost of Equal Volumes.
Sn 83·33, Sb 11·11, Cu 5·55	225°	1·63	0·01	6
Al 91·7, Cu 7·61	628°	0·81	0·008	1

The hardness test was carried out by Brinell's method, under 2,000 kg. pressure (size of ball not stated). In the rubbing test, a 1 sq. cm. surface of a block of the alloy was pressed with a force of 60 kg. against the edge of a cylinder of metal, 175 mm. diam., rotating at 800 r.p.m. for 1 hour, the surface being smeared with oil and emery powder. F. R.

1233. *Induced Draught with Hot-air Economisers.* **A. J. Capron.** (Iron and Steel Inst., Journ. 73. pp. 276–285, 1907. Abstracts in Engineering, 83. pp. 691–695, May 24, 1907. Mech. Eng. 19. pp. 810–812, June 8, 1907. Electrician, 59. pp. 589–590, July 26, 1907.)—This paper describes the application

of the Ellis and Eaves system of induced draught [see Abstract No. 690 (1901)] combined with an air-heating chamber or economiser to land boilers of the Marine, Lancashire, Stirling, and Babcock-Wilcox types, and gives some results of evaporative trials with coal and with gas firing. A series of plates gives illustrations of the arrangements employed with the different types of boilers. Rates of evaporation ranging from 9·74 to 11·98 lbs. of water per lb. of coal from and at 212° F. are recorded. Where comparative results are given a saving of coal of over 25 per cent. and an increase of thermal efficiency of boiler of 21 per cent. are shown. In the case of the Lancashire boilers fired with blast-furnace gas, the application of the hot-air system resulted in almost doubling the quantity of water evaporated per lb. of gas. A modified arrangement is described in which two fans are used, one to produce the induced draught and the other to force the air for combustion through the heater and into the furnace. This plan reduces the liability to leakage of cold air through the boiler setting. F. J. R.

GAS AND OIL ENGINES.

1234. *Gas Producer.* (Mech. Eng. 20. p. 465, Oct. 5, 1907.)—This article describes, with illustrations of central vertical sections, a new design of gas producer which is due to J. E. Dowson. The novelty in this design consists in using sprayed or "atomised" water with the air for combustion instead of steam. In the case of suction producers this involves the abolition of the vapouriser. Two arrangements are shown—in one a chamber or receiver is used containing water, and into the upper part of this air is forced by a pump at a pressure. Pipes with regulating cocks lead air and water to the atomiser, which is placed under the centre of the grate in an ash-box, with a door through which part or all of the air required for combustion can be drawn. Instead of air some of the exhaust gases from a gas engine may be conducted, while at some pressure, to the chamber or to the atomiser. In the other arrangement the water flows from a small tank or box by gravity to the atomiser, and the air or gas is led direct to it independently. F. J. R.

1235. *Use of Steam in Gas Producers.* **W. A. Bone** and **R. V. Wheeler.** (Iron and Steel Inst., Journ. 73. pp. 126–160; Discussion and Correspondence, pp. 161–180, 1907. Abstracts in Electrician, 59. pp. 590–592, July 26, 1907. Mech. Eng. 19. pp. 750–752, June 1; 813–817, June 8; 849–852, June 15, and pp. 880–883, June, 22, 1907. Metallurgie, 4. pp. 321–341, June 8, 1907.)—The authors carried out these experiments with the gas-producer plant at the works of Monks, Hall and Co., Ltd., Warrington, photographs and line illustrations of the plant being given. It consisted of two Mond-type producers with air-heaters, washer, gas-cooling and air-heating towers of the Mond arrangement, but without sulphuric acid tower. The experiments consisted principally in varying the proportions of steam and air used in the blast for the producers by raising the steam saturation temperature of the blast in five equal stages from 60° to 80° C.; accompanied by analyses of the coal and gas, and observations of all the conditions of such tests. The principal results of the five trials are summarised in the table which follows. In addition to these the average pressures under the grates of the producers and the temperatures of the gas (1) as it left the air-heaters, and (2) in the furnace main, for both day and night shifts throughout the trials, are shown in a page of line diagrams. The sulphur present in the gas, as H_2S, averaged

824 grains per 1,000 cub. ft., and the tar (anhydrous), removed by the washer and found in the gas passing on to the furnaces, averaged 5·75 per cent. of the weight of coal charged. The average amount of the carbon originally charged into the producer which appeared as permanent gas was as nearly as possible 92·8 per cent. The authors maintain that the "furnace efficiency" of the gas produced at the higher temperatures of blast saturation varies in greater degree than is indicated by the difference between the two *net* calorific values of 43·60 and 38·69 per cub. ft. for the gases obtained with steam saturation temperatures of 60° and 80° respectively.

Steam saturation temperature	60°	65°	70°	75°	80°
Coal consumption at producer, cwts. per hour	16·51	14·96	13·88	14·32	13·21
Coal consumption at boiler, cwts. per hour	2·0	1·8	2·38	2·37	3·35
Coal consumption for blast steam	nil	nil	0·66	1·17	1·65
Total carbon losses, per cent.	5·8	7·8	8·1	7·1	8·4
Mean percentage composition of gas obtained. Carbon dioxide	5·25	6·95	9·15	11·65	13·25
Carbon monoxide	27·30	25·40	21·70	18·35	16·05
Hydrogen	16·60	18·30	19·65	21·80	22·65
Methane	3·35	3·40	3·40	3·35	3·50
Nitrogen	47·50	45·90	46·10	44·83	44·55
Total combustibles	47·25	47·10	44·75	43·50	42·20
Calorific value of gas, gross	46·77	46·74	44·74	43·37	42·73
Calorific value of gas, nett	43·60	43·32	41·14	39·65	38·69
(Kg.-cals. per cub. ft. at 0° C. and 760 mm.)					
Yield of gas, cub. ft. per ton	138,250	134,400	141,450	145,800	147,500
Lbs. of steam in blast per lb. of coal gasified	0·45	0·55	0·80	1·10	1·55
Percentage of steam decomposed	87·4	80·0	61·4	59·0	40·0
Cub. ft. of air, at 0° C. and 760 mm., in blast per lb. carbon gasified	36·95	34·9	36·8	36·9	37·1
Ratio of $\frac{\text{oxygen from steam}}{\text{oxygen from air}}$	0·50	0·62	0·65	0·75	0·80
Ammonia in gas, as lbs. of ammonium sulphate per ton of coal	39·0	44·7	51·4	65·25	71·8
Efficiency ratios in actual trial— (1) Including steam for blower engine	0·778	0·750	0·727	0·701	0·665
(2) Including steam for blower engine and washers	0·715	0·687	0·660	0·640	0·604

In the *discussion*, **R. Armitage** maintained that the low output from the producers and the exceptionally good quality of the coal used accounted for the good results with low saturation temperature, otherwise they could not have been maintained successfully; and that with sufficient superheat of air and steam, at 85° C. the best ammonia recovery, high thermal efficiency, and greater freedom from clinkering would be obtained. The gas must be thoroughly cooled to remove water vapour. Leaving tarry vapours in the gas does not counterbalance the disadvantage resulting from the presence of water vapour. **A. Sahlin** instanced Morgan producers worked at 45° C. blast temperature producing gas with 3 per cent. CO_2. **B. H. Thwaite** had found that a steamless air-blown producer was generally more efficient than one with steam and air. **A. H. Lymn** gave instances of engines working successfully with gas containing 25 to 54 per cent. of hydrogen, and objected to the authors' procedure being taken as equivalent to general practice with Mond plant. **V. Stobie** advanced arguments as to loss in furnaces by

dissociation of steam and oxidation of iron to urge reduced employment of steam in producers. In *correspondence*, **G. W. Andrew** and **R. Booth** gave particulars of the working of Dawson producers at comparatively low saturation temperatures. **E. G. Sehmer** gave particulars of German practice with producers. **C. P. Williams** found the "pyrometric effect" of CO superior to that of hydrogen in furnaces. The **Authors** in reply combated the idea that the coal used was of exceptional quality, and gave proof of successful work at even 45° C. Originally worked at 80° C., the change in blast saturation temperature effected a saving of 24 per cent. of fuel at the producers and reduced furnace losses. The temperature of superheat varied between 220° and 260° C. The average temperature of gas leaving producers was 600° C., and the pressure after the washer was 5 to 6 cm. water gauge and 8 cm. at the furnaces. F. J. R.

1236. *Gaseous Fluid Turbine.* (Brit. Pat. 26,725 of 1906. Engineer, 104. p. 201, Aug. 23, 1907. Abstract.)—Deals with the construction of a turbine, due to C. Wedekind, formed of discs of metal having crowns of blades, the axis lines of which are parallel to the axis of rotation, riveted to them, the other ends of the blades being carried by a crown of sheet metal which serves to maintain them at the proper distance apart and to enable them to resist centrifugal force. Two parallel discs with blades face to face are arranged, the disc at the side of the exhaust collector having also fan blades to assist the exhaust. Nozzles are arranged round the periphery. A vertical section is given. F. J. R.

1237. *Analysis of Producer Gas.* **H. P. Smith.** (Chem. News, 96. p. 101, Aug. 30, 1907.)—The author pleads for greater co-operation between the chemist and the engineer in the working of gas producers, and gives factors showing how the results of the chemical analysis of producer gas can be utilised to yield the heating and power value of the gas. The following factors serve to convert the percentage by volume of any of the gases, into B.Th. Units per cub. ft., or kg.-cals. per cub. m.:—

	B.Th.U. per cub. ft.		Kg.-cals. per m³.	
	Total.	Available.	Total.	Available.
Carbon monoxide ...	3·419	3·419	30·43	30·43
Hydrogen	3·478	2·924	30·91	26·026
Marsh gas	11·278	10·133	100·38	90·225

The "available" heat units represent those obtained when the aqueous vapour passes off as steam. As an example of the use of these factors, the following is given:—

	Per cent.	B.Th. Units per cub. ft. Total.	Available.
Carbon dioxide	12·9 × —	nil	nil
Carbon monoxide ...	13·2 × 3·419	45·14	45·14
Hydrogen	24·8 × 3·478 or 2·924	86·18	72·51
Marsh gas	2·3 × 11·278 or 10·133	25·94	23·30
Nitrogen	46·8 × —	nil	nil
	100·00	157·21	140·95

To ascertain the maximum power development possible from this gas, one makes use, finally, of the relation between the ft.-lb., the h.p. and the B.Th. Unit (1 B.Th. Unit = 778 ft.-lbs; 1 h.p. = 33,000 ft.-lbs.). It must be remembered when applying the last factor that the efficiency of the best gas engine seldom exceeds 25 per cent. [?] J. B. C. K.

1238. *Nozzle with Side-opening.* G. Hagemann. (Zeitschr. ges. Turbinenwesen, 4. pp. 408–411, Sept. 30, 1907.)—In this paper the author discusses the pressure and velocity of the gas flowing through a special nozzle which has two outlets, one of these being in the side of the nozzle. The nozzle is for use with an explosion turbine, the wheel of which is specially shaped so that the pressure from both the side and end openings of the nozzle is utilised. For diagrams see original paper. The following advantages are stated to be obtained with the nozzle described in the paper: (1) Better utilisation of the jet pressure; (2) increase in wheel velocity, the two combining to give an increased mechanical efficiency. A. W.

AUTOMOBILISM.[1]

1239. *Air Resistance and Speed of Motor Cars.* (Automotor Journ. 12. pp. 1210–1212, Aug. 24, and pp. 1249–1250, Aug. 31, 1907.)—Experiments were carried out with wind screens attached to a Napier racing car. The nineteen screens varied from 2 to 30 sq. ft. in area, the area being generally an uninterrupted surface, and the speed of the car varied from 48·9 up to 79·0 miles per hour. Air resistance is generally taken to be AV^2 lbs. per sq. ft., A being a constant and V the speed in miles per hour, and A has been variously given as 0·005, 0·00365, and 0·0017 (adopted by the Royal Automobile Club). In the tests referred to, the car was run at as high a speed on the Brooklands racing track as each screen would permit. From horse-power and efficiency tests previously carried out at the works, it is deduced that a draw-bar pull of 86·1 lbs. was required to overcome tractive resistance, and that 249·6 lbs. were available for forcing the car through the air. A point of uncertainty is the cross-sectional area that should be allowed for the car and driver. Three sets of results are worked out, taking this at 10, 12½, and 18¼ sq. ft. respectively; actual measurement gave 12½ sq. ft. The numerical results are given and plotted, and from the curves it is seen the constant A decreases as the area of screen increases in the first two cases, but is fairly constant in the neighbourhood of 0·0022 when 18¼ sq. ft. is taken for the car area. The article concludes, however, that 0·003 is a reliable figure. The curves do not show a tendency to approximate to the same figure for the larger screens, though the divergence is less than with the smaller screens. W. R. C.

1240. *Crocco and Ricaldoni Hydroplane Boat.* (Engineering, 84. pp. 457 and 462, Oct. 4, 1907.)—An 8-metre boat propelled by aerial screws and an 80–100-h.p. motor. A speed of 70 km. (43·5 miles) per hour has been attained, the hull being at this speed raised completely out of the water and the boat supported solely by the V-shaped hydroplanes. L. H. W.

1241. *Aeroplanes.* W. R. Turnbull. (Phys. Rev. 24. pp. 285–302, March, 1907. Eng. Rev. 16. pp. 348–349, May, 1907.)—The author's special object was to find an aeroplane with automatic longitudinal stability. He found a type of double-curvature aeroplane which not only possesses the elements of automatic longitudinal stability, but also gives a very good "lift" and much reduced "drift" when compared with the single-curvature surfaces most commonly employed and looked upon as our most efficient lifting aero-

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

planes. The author divides all aeroplanes into five types: (1) The plane surface; (2) the single-curvature surface, convex on the under side; (3) the single-curvature surface, concave on the under side; (4) the double-curvature surface, concave at the forward portion, convex at the after portion, of the underside; (5) the same, with curvatures reversed. A typical form of the last two patterns has double the area in front in comparison with the back portion. Experiments were made with all the types in a wind of 18 miles an hour produced artificially by means of a fan. Lifts and drifts for various angles of inclination were thus determined. It was found that though type (3), on account of its excellent lifting qualities, is the favourite in the design of aeroplanes, it possesses no longitudinal stability, on account of a reversal in the movement of the centre of pressure as the angle approaches 26°. The centre of pressure moves back upon the centre of figure as the angle becomes smaller and approaches zero. Most aeroplane accidents are doubtlessly due to ignorance of this reversal. In types (2) and (4) the centre of pressure steadily advances to the forward edge of the plane, where the lifts both become negative. Hence these types have a perfect longitudinal stability. Type (4) is the only type possessing automatic longitudinal stability combined with a good lift and a small drift. It is exemplified in birds' wings. E. E. F.

REFERENCES.

1242. *Compounding Engines with Turbines.* A. Rateau. (Power, 27. pp. 693–697, Oct., 1907. Paper read before the Soc. of Belgian Engineers.)—The author explains, by means of entropy diagrams, the causes of loss in connection with the low-pressure cylinders in compound engines and by comparison shows the considerable saving in power by the substitution of a low-pressure exhaust-steam turbine installation. This system also shows economy as compared with the use of electric motors for intermittent service or with that of reversible electric motors as applied to rolling-mills. Various objections to the system which have been advanced are examined and answered. F. J. R.

1243. *Schulze Manograph.* (Automotor Journ. 12. pp. 824–826, June 15; 863–865, June 22, and pp. 899–902, June 29, 1907.)—Fully illustrated description of the complete instrument and the component parts, with typical indicator diagrams.

1244. *Morison's Condensing Plant.* (Engineering, 84. p. 406, Sept. 20, 1907.)—In this article the latest development of the "Contraflo" condensing plant of Richardsons, Westgarth and Co. [see Abstract No. 549 (1906)] is illustrated. It is being erected at the Grove Road Power Station of the Central Electric Supply Co., of London, and embodies the principal features of the system, which maintains the results already obtained, and in addition is found to conduce to great elasticity in air-pump capacity and to produce minimum aeration of the feed-water. This is of considerable importance for boiler feed-water. F. J. R.

1245. *High-pressure Centrifugal Fans.* A. Rateau. (Engineering, 84. pp. 248–251, Aug. 16, and pp. 287–288, Aug. 23, 1907.)—Fuller results of tests of the author's turbo-compressors [Abstracts Nos. 245, 246, 247 (1907)] are given.

1246. *Strength of Metals, Hot and Cold.* R. Baumann. (Stahl u. Eisen, 27. pp. 1301–1308, Sept. 4, 1907. Abstract of Habilitationsschrift, Techn. Hochschule, Stuttgart, 1907.)—A fairly exhaustive discussion of published results upon the strength of metals and alloys in the ranges of temperature in which they are used in construction. F. R.

INDUSTRIAL ELECTRO-CHEMISTRY, GENERAL ELECTRICAL ENGINEERING, AND PROPERTIES AND TREATMENT OF MATERIALS.

1247. *Measuring the E.M.F. and Capacity of Dry Cells.* **F. Stähli.** (Elektrotechn. Zeitschr. 28. pp. 869–870, Sept. 5, 1907. Elect. Engineering, 2. p. 551, Oct. 10, 1907.)—The author describes a simple arrangement for simultaneously measuring the e.m.f. and current of three cells by the aid of mercury switches and only one voltmeter and one amperemeter. The cells tested are of the Delafon, Hellesen, and Carbone types, about 100 measurements being made on each cell in the course of five months. The Hellesen cell, although the lightest, gave the largest number of watt-hours, 156, against 140 Delafon and 108 Carbone. Cells cut-out recovered, but the e.m.f. soon diminished to the former value again. H. B.

1248. *Nickel Alloys for Alkaline Accumulator Electrodes.* (Brit. Pat. 6,522 of 1906. Centralblatt Accumulatoren, 8. p. 128, Aug. 5, 1907. Abstract.)—The Nya Ackumulator Aktiebolaget Jungner replaces the Ni by Ni alloys. The permanency of Ni electrodes in caustic alkali is due to the fact that a film of a highly oxidised Ni is formed on the Ni anode, which film is invisible and insoluble in the alkali. But Ni electrodes are too expensive, and nickeled iron is attached when the surface is damaged. Nickel alloys containing 80 and more per cent. of Ni, are also insoluble, however, because the first-formed hydrate occupies more space than the Ni itself, and thus affords a surface protection. Recommended are the alloys: 30 to 40 parts of Ni, 70 to 60 of Cu; or 25 to 35 of Ni, 75 to 65 of Fe with a little copper. These metals all yield oxides which are insoluble in caustic alkali. Zinc and tin, whose oxides are soluble in alkali, may be added to increase the conductivity of the electrolyte and for other reasons. H. B.

1249. *Making Nickel and Cobalt Films.* (U.S. Pats. 865,687 and 865,688. Electrical World, 50. p. 555, Sept. 21, 1907. Abstracts.)—T. A. Edison produces films and flakes of Ni in Co, or of these metals combined with copper and with one another for his storage batteries in the following manner. In the case of Ni he starts from a copper cylinder, coppers it slightly, deposits a Ni film on it, strips the composite deposit from the kathode, and dissolves the Cu in ammoniacal copper sulphate; or he superposes several alternate films of Cu and Ni on one another, cuts the sheet into strips 10 in. long and 0·1 in. wide, extracts the Cu, and welds the Ni films together in a hydrogen atmosphere. The second patent first deposits 0·0001 in. of Co on the nickeled Cu cylinder, immerses the kathode in copper sulphate, from which a thin layer of cement Cu is deposited while the Co is redissolved, thickens this copper film in an ordinary galvanic bath, and adds another layer of Co. This may be repeated several times. The sheets are then cut into strips again, and placed in an agitated basket in a solution of KCN in which the Cu is extracted. Welding follows as before. H. B.

1250. *Preparation of Iron Oxide Electrodes for Accumulators.* **Peters.** Centralblatt Accumulatoren, 8. pp. 165–166, Oct. 20, 1907.)—Comments on

T. A. Edison's German Patents Nos. 180,672 and 190,268. According to the first patent, Edison starts from iron monosulphide, and transforms it electrolytically into an oxide by alternately oxidising and reducing it in 20 per cent. KOH solution. The second patent suggests the reduction of Fe_2O_3 in a hydrogen atmosphere at 400° or higher temperature; or to heat thin Norwegian sheet-iron to white glow, and at once to split off the oxide skin formed, by bending. These proposals were made because it was difficult to reduce chemically-prepared iron oxide by the current. Peters describes experiments with commercial iron sulphide, the crystallised hematite (Eisenglanz) and iron oxides prepared in various ways. He had no difficulty in reducing these compounds. H. B.

1251. *Porous Zinc Electrodes for Alkaline Accumulators.* (D.R.-P. 188,759. Centralblatt Accumulatoren, 8. pp. 122–123, Aug. 5, 1907. Abstract.)—H. Bründelmayer obtains porous zinc deposits on iron gauze by dissolving 8 kg. of crystallised zinc sulphate, 5 of ammonium sulphate, 4 of ammonium chloride, and 1 of boric acid in 1 litre of water, and electrolysing at 70 to 90° C. with current densities ranging from 1 amp./dm.^{2} at 75° C. to twice that density at 85° C. The e.m.f. of the bath need only be half that of solutions in hydrofluosilicic acid. H. B.

1252. *Use of Wooden Separators in Accumulators.* (Centralblatt Accumulatoren, 8. p. 158, Sept. 20, 1907. Brit. Pat. 22,807 of 1906.)—H. Leitner treats the wood by saturating the pores with a hypochlorite solution, which on addition of acids is decomposed and yields chlorine, which latter eliminates the undesirable substances in the wood, and can itself be extracted by washing without damage to the woody structure. The wood is first boiled in water for 12 hours, the water withdrawn, and 0·5 per cent. calcium hypochlorite solution added, after which the wood is washed. It is then kept in sulphuric acid of 1·01 sp. gr. for 12 hours, and finally boiled for three successive periods of 6, 12, and 18 hours. Such separators can be kept in the air, especially if boiled for 24 hours in a 0·125 per cent. solution of tragacanth. Another method of freeing the wood from harmful substances, and making it porous, is disclosed by C. Haunz and the A.B.P. Accumulator Co., Ltd., in Brit. Pat. 17,589 of 1906. (Ibid. pp. 141–142, Sept. 5, 1907. Abstract.) The wood is here treated with caustic alkali solution under pressure. The boards are put in 5–10 per cent. hot sodium hydrate solution for 6–8 hours under a pressure of 9 atmos. above atmospheric. The brown to black-coloured treated boards are quickly washed in running water, and immersed in 3–6 per cent. sulphuric acid for a short time. The original colour of the wood is thus restored. The separators must be stored in water or weak acid as usual, but the treatment is very rapid and simple. A third patent, that of the Akkumulatorenfabrik-A.G. (Ibid. p. 122, Aug. 5, 1907, D.R.-P. 188,567), describes a process whereby only the resinous substances are extracted, the starchy elements being left in the wood to assist in maintaining the capacity of the negative plates. The wood is treated with alkaline solutions of hydroxides, carbonates, silicates, or borates. L. H. W.

1253. *Manufacture of Electric Resistance Bodies.* (U.S. Pat. 864,728. (Electrochem. Ind., N.Y. 5. pp. 412–413, Oct., 1907. Abstract.)—F. Bölling heats carborundum, siloxicon, borides, &c., in an electric furnace in order to transform the small particles into a porous mass. The mechanical strength can be increased by dipping the product into an enamel and firing; or the

powdered materials may be mixed with a cementing substance, e.g., artificial corundum. The melting-point of the mass is then reduced to 1,500° C. however, and the electric resistance is increased. Compressed mixtures of 8 parts of amorphous carborundum and 1 part of boric acid fired at 1,200° give rheostat materials suitable for lamps and heating resistances, but they soften above 800° C. H. B.

1254. *Copper or Lead from Sulphides.* (U.S. Pat. 862,871. Electrochem. Ind., N.Y. 5. p. 415, Oct., 1907.)—E. L. Anderson reduces sulphidic ores in tanks charged with hydrofluosilicic acid and carbon electrodes. The ore is packed between the kathode and a perforated wooden diaphragm, which is covered with canvas on the side facing the kathode. When this electrode is kathode, H_2S is given off, and the metal is reduced. The current is then reversed, the Cu goes into solution as $CuSiF_6$, and is deposited on the copper sheet covering the other electrode. Any iron sulphide present is said to remain unreduced, and to collect in the cell mud. H. B.

1255. *Metal Reduction by Mixtures of Metals and Oxides.* (Brit. Pat. 8,089 of 1906. Zeitschr. Elektrochem. 13. p. 676, Oct. 11, 1907. Abstract.)—E. Maemecke effects reductions on the Goldschmidt plan with the aid of mixtures of Mg and Si. When 15 per cent. of Mg are mixed with 10 of Si and 75 of Fe_3O_4 and Fe_2O_3, a readily fusible slag, 3·5 MgO, $2SiO_2$, and molten iron result. In this manner Cr, Mn, Mo, ferro-titanium, and other alloys can be reduced. The excess of oxide is to prevent contamination of the reduced metal with Si or Mg; fluxes, lime and fluorspar, and further metallic Al, Ca, Ba, and even Na may be added. Instead of silicon a high-grade ferro-silicon can be applied, and sulphates, sulphides, nitrates, &c., can be reduced like the oxides. H. B.

1256. *Fixation of Atmospheric Nitrogen.* (U.S. Pat. 865,618. Electrical World, 50. p. 555, Sept. 21, 1907. Abstract.)—C. P. Steinmetz produces a long direct-current arc between vertically arranged electrodes in a cylindrical chamber. The arc is deflected, and the two opposing electromagnets are rotated round the outside of the cylinder by an electric motor, so that the field rotates. The air is drawn through the chamber so as to pass upward through the deflected arc. H. B.

1257. *The Electrothermic Reduction of Iron Ores.* A. E. Greene and F. S. MacGregor. (Electrochem. Ind., N.Y. 5. pp. 367–371, Sept., 1907.)—The authors have carried out an experimental investigation in the electrochemical laboratory of the Massachusetts Institute of Technology upon the electrothermic reduction of iron ores containing titanium. The points covered by the investigation were: (1) The best design and construction for a 30-kw. furnace. (2) The best means of measurement of the temperature of the molten charge. (3) The factors affecting the temperature and the best methods of regulating it. (4) The effects of variation in the temperature and composition of the charge, upon the quality of the iron produced. (5) The calculation of the amount of electric energy per ton of pig iron. The early trials of the furnace were made with two samples of iron sand from the Pacific coast, but these did not lead to any conclusive results relating to their possible value as a source of iron. The titaniferous ore with which the more important experiments were made was from Essex County, N.Y., and

contained 70·40 per cent. Fe_3O_4, 26·40 per cent. TiO_2, and 1·99 per cent. SiO_2. It contained practically no sulphur or phosphorus, and only traces of alumina and manganese dioxide. The best grades of Pocchontes coke and of burned lime were used as other raw materials. The electric energy was transmitted at 1,100 volts from the power plant of the Institute to the furnace laboratory, where it was transformed down to voltages varying from 10 up to 160, and applied directly to the furnace. The furnace design and construction was altered several times during the experiments, the furnace finally adopted being of the following dimensions: Height, 24 in.; length of side, 28 in.; depth of crucible, 8 in.; size of upper portion of crucible, 9 in. square; size of base, 5 in. square; distance from bottom of crucible to top of furnace, 15½ in. A graphite block was used as crucible base, this block resting directly upon an iron bed-plate ½ inch thick, to which the electrical connections were made. Flour, carbon, and molasses were used as a lining to the corborundum bricks which formed the lower part of the crucible. The other electrode was movable, and consisted of a graphite block, 4 in. square by 40 in. in length, slung upon chains and a pulley over the vertical shafts of the furnace. The temperature measurements were made by means of a Wanner optical pyrometer reading from 0° C. to 4,000° C., the actual tests being made by aid of a horizontal plugged tube entering near the base of the furnace-crucible, or by direct observation of the surface of the charge, as seen from the open top of the furnace shaft. The power-factor of the furnace was approximately constant at 92 per cent. The following table summarises the results obtained in the most satisfactory runs :—

Run. No.	Ratio $\frac{CaO}{Al_2O_3 + SiO_2 + TiO_2}$.	Per Cent. SiO_2 in Metal.	Per Cent. Ti in Metal.	Per Cent. Fe in Slag.	Temperature of Molten Charge Degrees C.	Quality of Slag.	Electric H.P.-Years per Ton of Pig.
7	$\frac{2·25}{2·90}$	0·10	0·00	2·95	1,875	Medium fluid...	1·14
10	"	0·11	0·00	7·10	1,598	Fluid	2·25
11	$\frac{3·50}{2·90}$	0·13	0·00	6·37	1,549	Infusible and viscous	0·97
12	"	0·23	0·00	7·56	1,675	Infusible and viscous	0·93
13	$\frac{0·75}{2·90}$	0·30	0·20	—	1,922	Very fluid	1·22
14	"	0·44	0·04	—	1,469	Very fluid	0·745

The conditions under which the reduction of the titanium oxide in these ores commences are of great importance, and the results show that no Ti was reduced until the lime content of the slag was made small. In runs Nos. 13 and 14. Using a ratio of lime to other materials of $\frac{0·75}{2·90}$, small amounts of Ti were found in the reduced metal, while in runs Nos. 7, 10, and 11, using a much higher lime ratio, no Ti was found. The lowest amount of electrical energy required in any of the runs was found to be 0·75 e.h.p. year per ton of pig. The results of run No. 13 show that in order to smelt a

charge at 1,922° C., electrical energy equivalent to 0·475 e.h.p.-year was required in excess of that required to smelt charge No. 14 at a temperature 1,469° C. or 453° C. lower. J. B. C. K.

1258. *Calcium Carbide and Phosphorus.* (U.S. Pats. 862,092 and 862,093. Electrochem. Ind., N.Y. 5. p. 412, Oct., 1907. Abstracts.)—J. T. Morehead mixes 100 lbs. of calcium triphosphate with 55 of coke or charcoal and 8 of lime, all finely ground (calcined bones can also be used), and heats them in an electric furnace in a reducing atmosphere. Phosphorus vapours escape, and are condensed under water. The carbide gained is impure and dangerous because it contains phosphide ; on adding water acetylene and phosphuretted hydrogen are liberated, and the latter burns to phosphoric acid. It is proposed to charge this impure carbide into shells or cartridges for discharge from a gun, in order to illuminate the water at a distance. H. B.

1259. *Regulating the Iron Reduction in Electric Furnaces.* (U.S. Pat. 861,280. Electrochem. Ind., N.Y. 5. p. 411, Oct., 1907. Abstract.)—In his furnaces in which the crucible forms the one, and a vertical carbon the other electrode, P. L. T. Héroult claims to regulate the silicon content of the iron by adjusting the quantity of lime added to the charge. This lime forms a lining on the side walls of the furnace, when in excess ; when deficient, the slag will dissolve this lining or scale. The cross-section of the zone of fusion will thus be altered. When this section is reduced, the electrode is automatically lifted up, the incandescent carbon column becomes longer, the resistance of the arc greater, and the arc shorter. The reactions are hence less rapid, and the reduction is more complete ; and as the silicon is, broadly speaking, reduced after the iron, the silicon percentage will be increased. H. B.

1260. *Steel Refining.* (U.S. Pat. 851,167. Electrochem. Ind., N.Y. 5. pp. 411–412, Oct., 1907. Abstract.)—P. L. T. Héroult oxidises the metal to such an extent that all impurities pass into the slag which is kept liquid while the iron solidifies. The slag is then poured off, and the iron re-melted and refined. The process may be applied to an open-hearth or an electric furnace of the tilting type. Crucible steel (1 per cent. carbon) melts at 1,400° C., soft steel (0·1 per cent. carbon) at 1,600°, pure commercial iron at 1,900° C. If the pure iron is over-oxidised, however, it will melt below 1,600°. The iron is hence over-oxidised and then deoxidised, when it will begin to solidify so that the slag can completely be poured off. Carburising materials are then added to the re-melted iron. He starts with scrap, deoxides with pig iron, and takes an ordinary slag of lime, sand, and clay. H. B.

1261. *Electrostatic Separation and Concentration of Ores and Minerals.* F. Esser. (Metallurgie, 4. pp. 592–598, Sept. 8, and pp. 607–618, Sept. 22, 1907.) —This investigation into the practical value of electrostatic methods of concentrating ores and minerals was carried out by the author, at the instigation of the Metallurgische Gesellschaft of Frankfort, and of the Maschinenbau Anstalt-Humboldt, of Kalk, near Cologne. The results obtained are summarised as follows : (1) The electrostatic method of concentration can only be employed with success for ores and minerals broken down to a uniform size of particle, the most suitable size being that ranging from 1 mm. up to the product of Sieve No. 200. Fine dust cannot be dealt with by this method. (2) The particles of material after crushing must be uniform

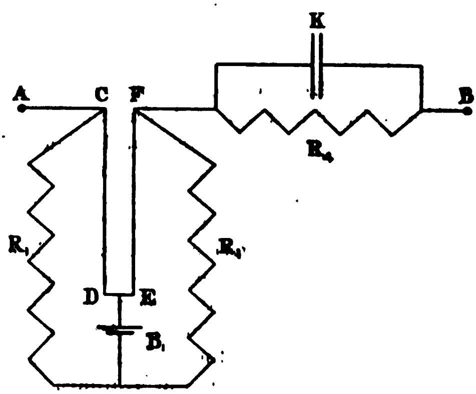
in their chemical and physical composition—any great variations in the composition of the particles will produce unsatisfactory separation of the minerals. (3) Minerals and ores which are classed as "impregnated" are not suited for electrostatic treatment. (4) Impurities of an ore, which vary in amount, influence the electrostatic concentration or separation unfavourably. The presence of pyrites in zinc blende is an example of this; and for this reason zinc blendes containing only small amounts of pyrites are preferable for electrostatic treatment. (5) The climate has some influence upon the results, and the above four rules apply only to countries with a climate similar to that of Germany. Better results could be obtained in countries like Chile and Bolivia, high above the sea-level, and possessing a much drier atmosphere. J. B. C. K.

1262. *Industrial Liquid Air.* (Electrochem. Ind., N.Y. 5. pp. 426–428, Oct., 1907.)—Notes on liquid air and on the works of the Linde Air Products Co., in the course of erection at Buffalo, N.Y. The information was supplied by C. Lightfoot. The "heat interchanger" is a coil of three concentric copper pipes. Air compressed to 200 atmos. passes down the innermost pipe, is expanded to 50 or 20 atmos. and returns through the middle pipe. There are two valves below, and through the second valve part of the air is allowed to escape up into the outer pipe, at atmospheric pressure, after equilibrium is established; part of this air is liquefied and flows into the collector. A corresponding amount of "make-up" air is introduced through the first of the pumps in which the compression is effected. This pump works at 4 atmos., and delivers its air into the low-pressure cylinder of the compressor, where the compression is carried to 50 atmos. The high-pressure cylinder compresses this air and the air from the middle pipe further to 200 atmos., and sends it through the cooler (an ammonia machine) and a calcium chloride drying apparatus back into the interchanger. The plant is in duplicate. Statements as to power and capacity are not made. H. B.

1263. *New Testing Set of European Weston Electrical Instrument Company.* **C. Paulus.** (Elektrotechnik u. Maschinenbau, 25. pp. 749–752, Sept. 29, 1907.)—In this testing set a Weston standard cell is employed as the ultimate standard of reference. The set consists of a voltmeter, a millivoltmeter (which serves as an ammeter when connected across suitable shunts), and a delicate galvanometer for use with the compensating circuit of the standard cell. The voltmeters are provided with adjustable magnetic shunts. The method of standardising the voltmeter is as follows; By means of a variable resistance the p.d. across a section of the series resistance of the voltmeter is adjusted until it balances the e.m.f. of the standard cell. If the voltmeter is correct its pointer will then stand at a reference mark consisting of a red line. Should the pointer be to one side or other of this line it is made to coincide with it by altering the magnetic shunt of the instrument. The great advantage of the method is the possibility of standardising the instruments in the exact position in which they are to be used, so that the effect (if any) of stray magnetic fields is allowed for. A. H.

1264. *The Irwin Oscillograph.* **J. T. Irwin.** (Inst. Elect. Engin., Journ. 39. pp. 617–642; Discussion, pp. 643–647, Sept., 1907. Abstracts in Electrician, 59. pp. 266–267, May 31, and pp. 306–307; Discussion, p. 307, June 7,

1907. Elect. Engineering, 1. pp. 970–978; Discussion, p. 978, June 6, 1907. Écl. Électr. 52. pp. 177–180, Aug. 3, and pp. 215–216, Aug. 10, 1907.)—The author first describes his oscillograph for recording the instantaneous values of the voltage. The oscillograph consists of two strips CD and EF of metal immersed in oil, a storage battery B_1 and two equal resistances R_1, R_1. For recording voltages a high resistance R_4 shunted by a condenser K is placed in series with the oscillograph and the terminals A and B are connected across the mains the voltage between which is to be measured. Let r be the resistance of either CD or EF, i the instantaneous value of the alternating current, c the direct current in either strip, m the mass in gm. of each strip, s the



specific heat of the metal, S the surface of each strip, and h Newton's constant for thermal emissivity. Then if θ, θ' be the excess of the temperatures of the strips CD and EF over the room temperature, we have—

$$(r/4{\cdot}2)(c+i)^2 = sm\,d\theta/dt + hS\theta,$$

and—

$$(r/4{\cdot}2)(c-i)^2 = sm\,d\theta'/dt + hS\theta'.$$

Therefore—

$$\frac{4rc}{4{\cdot}2}i = sm\frac{d}{dt}(\theta-\theta') + hS(\theta-\theta')\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

If K be the capacity of the condenser and v the p.d. across its terminals, we obviously have—

$$i = \mathrm{K}dv/dt + v/R_4\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Comparing (1) with (2) we see that v will be proportional to $\theta-\theta'$, provided that $\mathrm{K}/sm = hR_4$. The problem therefore simplifies to devising a method of recording $\theta-\theta'$. If the wires CD and EF are each drawn back with equal and constant tension at their middle point, then a small mirror placed across the two wires will be deflected through a certain angle proportional to the difference of temperature. It is extremely difficult, however, to make this arrangement, and so the wires CD and EF in the Fig. instead of being pulled back at their middle point pass over independent and insulated pulleys and return almost parallel to each other. The systems of wires are tied diagonally and the mirror is attached to both. The wires are kept tight by a spring supporting the pulleys, and there is no relative motion if they are at the same temperature. The free period of the mirror is exceedingly small, and its angular displacement is proportional to the difference of temperature. Hence by means of a beam of light a synchronous motor and a vibrating

mirror an oscillogram can be obtained. To use the instrument for recording the current, K and R_4 (see Fig.) are removed and a choking coil R,L placed between C and F. Our equations are now—

$$\frac{4c_1}{4\cdot 2} i = Sm \frac{d}{dt}(\theta - \theta') + hS(\theta - \theta'),$$

and—

$$e = r'i = Ri' + Ldi'/dt,$$

where r' is the resistance of the circuit CDF in the Fig. and i' is the current through the choking coil. Hence i' will be proportional to $\theta - \theta'$ if $Sm/R = hS/L$. The author, utilising a theorem given by M. B. Field in the patent specification for his hot-wire wattmeter, describes an oscillograph giving the instantaneous value of the power expended in a circuit. Finally he gives a method of obtaining oscillograms of hysteresis loops. Numerous experimental results and constructional data are given in the paper, and oscillograms are shown to illustrate that the Irwin and Duddell instruments give practically identical results in certain cases. A. R.

1265. *Mains Ohmmeter.* (Elect. Engineering, 2. p. 665, Oct. 24, 1907.)—The insulation resistance of a network may be readily determined by A. Russell's method, the reading i of the ammeter in the earthing connection being first taken, and then the reading V of a voltmeter connected between the neutral and earth when the earthing connection is momentarily interrupted. If r = resistance of earthing circuit, then the insulation resistance of the network is given by $\frac{V}{i} - r$. W. E. Groves has designed a direct-reading instrument on this principle. The instrument consists of an ammeter and a voltmeter mounted at opposite corners of a lozenge-shaped case, the long pointers of the instruments overlapping. By opening a switch which normally short-circuits the ammeter shunt, the ammeter pointer is deflected; by then opening a second switch the ammeter pointer is first locked in position by a small electromagnet, and the earthing circuit is immediately afterwards opened, allowing the voltmeter to give its reading. Corresponding to each point of intersection of the two pointers, the insulation resistance has a definite value, and by means of a series of lines, each of which corresponds to a definite value of the insulation resistance, its value for any point of intersection of the two pointers may be read off. In addition to the set of lines occupying the central portion of the scale card and giving insulation resistances, each instrument is provided with an ordinary scale. The instrument is being made by Elliott Bros. A. H.

1266. *Automatic Switch for Earthing Neutral of Three-phase System.* E. V. Shaw. (Elect. Rev. 61. pp. 643–644, Oct. 18, 1907.)—The earthing switch devised by the author is intended primarily for use in connection with Westinghouse remote-control switchgear. It is so arranged that the neutral point of only one generator at a time is earthed, and when this generator is thrown out of circuit by its oil-switch, a pilot switch carried by the oil switch closes the circuit of the small continuous-current motor which operates the earthing switch, causing the contact brush of the switch to travel along the array of contacts until it reaches a contact which is in connection with the neutral point of a live generator, whose neutral point it earths, the circuit of the small motor being automatically interrupted immediately afterwards. A pilot lamp indicates the earthed generator. The earthing takes place through a suitable resistance. A. H.

1267. *Alternating-current Relays of the Ferraris Type.* **R. David** and **K. Simons.** (Elektrotechn. Zeitschr. 28. pp. 941–944, Sept. 26, 1907.)—In the first part of the paper the authors deduce a general expression for the torque exerted on a metal disc by two alternating magnetic fields having a given phase-difference. The various possible practical applications of the device are next considered. Two types of construction are in general possible: in the first, two currents having a given phase-difference are led into the windings of the apparatus; while in the second a single-phase current is supplied to the windings, and by means of short-circuited coils which are linked with a portion only of the total flux a phase displacement is produced between this portion and the remainder of the flux. Assuming proportionality between the flux and the current in the relay coil, we may construct the relay so as to make the torque exerted by the metal disc proportional to (1) the square of the main current I in the given circuit; (2) the square of the p.d. V across the mains; (3) the product VI $\sin\psi$, where $\psi = \phi + \theta$, ϕ denoting the variable phase-difference between V and I, and θ the constant phase-difference between V and the current in the shunt coil ($\theta = 90°$ in wattmeters and energy meters). The various possible arrangements of relays of this type are divided by the authors into three groups: (A) those in which a mechanical torque opposes a single torque due to electromagnetic action, which may be of the nature of (1), (2), or (3)—corresponding to maximum or minimum current, no-voltage, and maximum or reverse-current relays respectively; (B) a mechanical torque acts in conjunction with two out of the three torques (1), (2), and (3), viz.: (1) and (2)—giving a combined maximum-current and no-voltage relay; (2) and (3)—corresponding to a combined maximum-current, reverse-current, and no-voltage relay; and (1) and (3)—giving a combined maximum and reverse-current relay; (C) a mechanical torque acts in conjunction with all of the three torques (1), (2), and (3), yielding a combined maximum-current, reverse-current, and no-voltage relay. The characteristic features of the various types and their relative advantages are briefly discussed. A. H.

1268. *The Arc as a Source of High-frequency Currents for Measuring Purposes.* **C. Heinke.** (Elektrotechn. Zeitschr. 28. pp. 913–917, Sept. 19, 1907.)—Across the terminals of a small (3-amp.) arc between homogeneous carbons the author connects a small (1 mfd. or less) paraffined paper condenser joined in series with a small self-inductance. The high-frequency currents obtained in such an oscillating circuit are extremely useful for measuring self and mutual inductances and capacities. The oscillations are prevented from entering the main circuit by a suitable inductance connected in series with the arc. Finding telephone bridge methods unsatisfactory, the author prefers to employ methods involving the use of ordinary hot-wire ammeters and hot-wire or electrostatic voltmeters. The following are examples of such methods: To compare two self-inductances, these—if small enough—are connected in series and are introduced into the oscillating circuit itself, replacing the self-inductance ordinarily used in this circuit. An ammeter included in the same circuit measures the current; a voltmeter connected in succession across the known and the unknown self-inductance enables the latter to be determined. If the self-inductances are too large for a series connection they may be connected in parallel, and the currents in them measured by two ammeters, the p.d. being given by a voltmeter. Similarly a series connection of an unknown capacity and a known self-inductance enables the former to be determined. The following method of determining the equiva-

lent capacity of a non-inductive bifilar resistance for a wattmeter is of great interest. Across the terminals of the self-inductance in the oscillating circuit are arranged three parallel paths: the first consists of a voltmeter, the second of an ammeter in series with a known self-inductance, the third of an ammeter in series with the wattmeter resistance under test. The readings of the instruments in the first two paths enable the frequency to be determined; the equivalent capacity of the bifilar resistance is then easily found. The actual value for a 500-ohm resistance of this type was found by the author to be $1{\cdot}18 \times 10^{-4}$ mfd. A. H.

1269. *Relation connecting Hysteresis Loss with Frequency and Wave-form.* **J. Sahulka.** (Elektrotechn. Zeitschr. 28, pp. 986–988, Oct. 10, 1907. Elektrotechnik u. Maschinenbau, 25. pp. 808–812, Oct. 20, 1907. Paper read before the Verband Deutscher Elektrotechniker, Hamburg.)—The problems investigated experimentally by the author were the dependence of the hysteretic loss *per cycle* on the frequency and on the shape of the induction wave. The apparatus employed consisted of a ring-shaped core of silk-covered iron wire, 0·18 mm. in diam. (so that the eddy-current loss was inappreciable), provided with primary and secondary windings; the mean circumference of the ring was 107·1 cm., its cross-section being 4·86 sq. cm. The core loss was measured by a wattmeter, due allowance being made for the primary copper loss. The secondary was connected to a moving-coil instrument through a half-period contact-maker [Abstract No. 1480 (1900)], by means of which the maximum induction B could be easily measured. Although the invention of the half-period contact-maker is generally ascribed to F. Townsend, the author gave a description of it at an earlier period (1898). Three sets of observations were taken connecting the loss per cycle per kg. of iron with B, the frequencies being 20, 31, and 48·33 respectively. The loss per cycle at a given frequency was found to increase less rapidly than in accordance with Steinmetz's law; while for a given B the loss per cycle was found to increase with the frequency, differences of up to 9 per cent. being obtained between frequencies of 20 and 48·33. An inspection of the author's curves shows relatively little difference between the two higher frequencies, and a relatively large difference between the two lower frequencies. In accordance with this result it was found that, using a given B and given frequency, the loss per cycle increased with increasing distortion of the induction wave. This confirms some of Benischke's results [Abstract No. 187 (1906)]. A. H

1270. *Permeability of Iron Alloys at High Flux Densities.* **E. A. Watson.** (Electrician, 60. pp. 4–5, Oct. 18, 1907. Écl. Électr. 53. pp. 239–241, Nov. 16, 1907.)—Although often used in constructing transformers, little use has been made up to the present in constructing dynamos of the iron alloys having small hysteresis and low eddy-current losses. The reason of this may be due to the greater expense and lower permeability of these alloys. At G. Kapp's suggestion the author has carried out experiments in the Birmingham University electrical engineering laboratories to measure the permeabilities of various kinds of iron alloys at the flux densities customary in the teeth of slotted armatures. The samples tested were four in number. Nos. 1 and 4 were Sankey's "Stalloy" and "Lohys" respectively, and Nos. 2 and 3 were of German origin. Samples Nos. 1, 2, and 4 were from 0·35 mm. sheets, and No. 3 from 0·3 mm. sheet. Curves are given of the relation between the flux densities and the ampere-turns per unit length. They show that the "Lohys" iron is the most per-

meable of the iron alloys, but the difference between them is not very great. It is probable, however, that "Lohys" iron at these high flux densities is not quite as permeable as the iron sheets used in armature construction. The alloys differ appreciably in their magnetic properties from one another. One of the German samples is much more permeable than the other at the high flux densities, but it has the same permeability at low densities. In no case, even with a magnetising power of upwards of 1,000 amp.-turns per cm., did the flux density in the iron alloys reach 22,000. The flux densities, however, were the true flux densities, there being no paper or other insulating material placed between the strips. Considering the great decrease of the constant losses with these iron alloys their extended use in constructing electrical machinery of all descriptions would be advantageous. A. R.

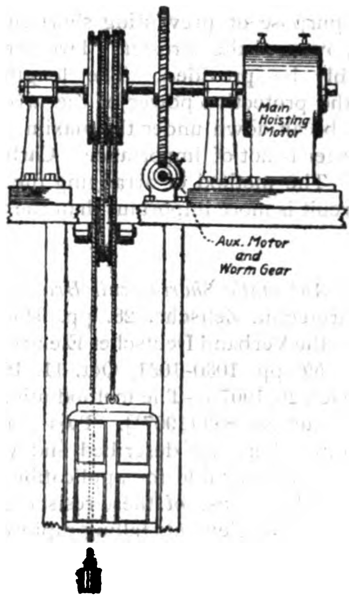
1271. *Sparking Voltages.* **M. Toepler.** (Elektrotechn. Zeitschr. 28. pp. 998–1001, Oct. 10, and pp. 1025–1026, Oct. 17, 1907. Paper read before the Dresdener Elektrotechn. Verein, Feb. 21, 1907.)—This paper contains a brief review of our knowledge of sparking voltages under various conditions. Tables of experimental results obtained by different observers are given, and from an examination of the available data the author concludes that the breaking down of a dielectric is not determined solely by the maximum potential gradient. In dealing with the sparking voltages between needle electrodes as used for purposes of measurement, the author emphasises the necessity of carefully removing all disturbing influences, such as the near presence of other conductors or large masses of insulating material. A. H.

1272. *Design of Plunger Magnets.* **C. P. Nachod.** (Electrical World, 50. pp. 563–564, Sept. 21, 1907.)—Treats of the pull when the relative proportion of copper to iron in the coil and core in a given sized ironclad stopped plunger magnet with given length of stroke, and to operate at a specified temperature-rise, is varied. The increase in copper is of course at the expense of the diam. of the plunger. The calculations are made for a definite sized magnet, and are plotted in curves. The maximum pull is obtained when the plunger is 56·7 per cent. of the outside diam. of the coil. E. C. R.

1273. *Constants of Alternate-current Cables.* **C. Breitfeld.** (Elektrotechnik u. Maschinenbau, 25. pp. 705–712, Sept. 15, 1907. Écl. Électr. 53. pp. 93–97, Oct. 19, and pp. 133–136, Oct. 26, 1907.)—In determining the effects due to the resistance and capacity of cables in alternate-current working, two constants are of fundamental importance: the impedance of the cable when open-circuited, and its impedance when short-circuited. If these are known for a given length of cable, their values for any other length may be calculated. The calculation is in general complicated, but the author shows that, within the limits likely to arise in practice, the amplitude of the short-circuit impedance is practically proportional, and the amplitude of the open-circuit impedance inversely proportional, to the length of cable; and that the changes in the phase angles of the impedances also follow fairly simple laws. A. H.

1274. *Pratt's Positively-controlled High-speed Electric Lift.* (Eng. News, 58. pp. 846–847, Sept. 26, 1907. Mech. Eng. 20. pp. 544–545, Oct. 19, 1907.)—For the high-speed lifts required in exceedingly high buildings that are now so numerous in New York, hydraulic lifts are quite out of the question, and resort is made to electric traction. Sufficient re-

liance cannot be placed upon a friction brake in connection with high-speed lifts, and the article describes a positively controlled lift invented by Pratt, and constituting a feature of the Sprague-Pratt system of electric lifts. In this system the main shaft is direct-driven by the armature of an electric motor through which some 90 per cent. of the power is supplied. The remaining 10 per cent. or thereabouts is supplied through a small motor which drives a worm engaging with a large gear on the main shaft. These two motors are generally connected in series. The main motor is of sufficient power to take the gravity load; the speed of the small motor is such as to rotate the worm which will permit the main or hoisting motor to run at suitable speed for the operation of the car. The rotating worm keeps the car at a fixed speed, and transmits to the hoisting apparatus a motion which



synchronises with all normal action of the lift and resists all abnormal action. Suitable means are provided, with control located in the car, for varying the speed of the worm-gear motor. By this means the descent of the car at slow speed may be retarded by the worm, thus enabling a saving of current in the main motor to be effected. Accidents involving sudden dropping of the car are prevented owing to the low pitch of the worm. Since the load on the worm gear when in motion is very small indeed, the wear upon it is almost negligible. The arrangement is shown in the Fig. H. M. H.

1275. *Lightning Arrester.* (Electrical World, 50. p. 607, Sept. 28, 1907.)—The lightning arrester system devised by E. J. Berg (U.S. Pat. 868,778) is earthed and the line conductor connected to the motor (here used on a direct-current electric railway of 600 volts) through an impedance coil. Two condensers, in series, shunt this coil, and are earthed where connected to each other. The condensers, which may be of the ordinary or electrolytic type, and should have as little inductive reactance as possible, serve the purpose of permitting a free path for any high-frequency, high-voltage

oscillations, and therefore reduce the potential gradient in the motor winding. The impedance, which should have as little capacity between its coils as possible, causes a partial reflection point for the high voltage, and therefore reduces the voltage on the motor winding. The line is further connected to earth through a spark-gap with a blow-out magnet. E. C. R.

1276. *Comparison of Various Types of Lightning Arresters.* **F. Neesen.** (Elektrotechn. Zeitschr. 28. pp. 967–971, Oct. 3, 1907.)—The author has carried out a number of tests on various forms of lightning arresters, employing the method described in Abstract No. 748 (1905). Among the more important conclusions arrived at by him are the following: All connections forming part of the lightning-arrester system should have the least possible self-inductance. The introduction of water resistances into the lightning-arrester circuit for the purpose of preventing short-circuits almost entirely destroys the protective power of the arrester. Two arresters, connected in parallel, should invariably be provided. The length of spark-gap has practically no effect on the protective power of the arrester, so long as this gap is short enough to break down under the maximum safe voltage. The size of the lightning arrester is not of importance. Carbon electrodes are as efficient as metal ones. The method of arranging the conductors forming the lightning-arrester circuit is more important than the type of arrester. A. H.

1277. *New Method of Automatic Short-circuit Braking for Electric Motors.* **M. Kallmann.** (Elektrotechn. Zeitschr. 28. pp. 945–948, Sept. 26, 1907. From a paper read before the Verband Deutscher Elektrotechniker, Hamburg, June, 1907. Electrician, 59. pp. 1080–1081, Oct. 11, 1907. Abstract. Écl. Électr. 53. pp. 181–183, Oct. 26, 1907.)—The method utilises the author's iron-wire resistances [see Abstract No. 898 (1907)]. Two forms of such resistance sealed in a hydrogen atmosphere are described and various arrangements of circuits and switches shown, suitable for application under different conditions. It is claimed that by the use of these resistances motors can safely be short-circuited, the resistance elements falling rapidly in resistance at the same time that the motor speed decreases, whereby a final nearly zero resistance is across the motor terminals. L. H. W.

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1278. *Enamel Wire (Acetate Wire).* **R. Apt.** (Elektrotechn. Zeitschr. 28. pp. 996–998, Oct. 10, 1907. Paper read before the Elektrotechn. Verein, May 28, 1907. Écl. Électr. 53. pp. 237–239, Nov. 16, 1907.)—Curves are given showing the space factor, length per unit weight, and insulation resistance of acetate wire as compared with other coverings. The breaking-down voltage of the acetate wire is given as 900 volts when immersed in mercury and 400 volts when in water. [See also Abstract No. 1282 (1905).] L. H. W.

1279. *Single-phase Supply Meter.* (Elektrotechn. Zeitschr. 28. pp. 991–992, Oct. 10, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—An illustrated description of a single-phase meter manufactured by the Isaria-Zähler-Werke, of Munich. The meter is of the induction type, having a rotor consisting of an aluminium disc, acted on by the usual series and shunt electromagnets, and by a permanent braking magnet. The phase displacement of 90° between the p.d. and the working flux of the shunt magnet is obtained by placing a band of copper around its pole. A. H.

GENERATORS, MOTORS, AND TRANSFORMERS.

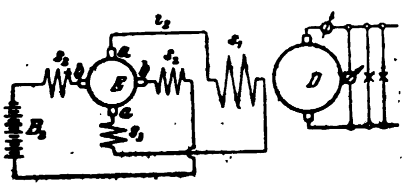
1280. *Method of Dynamo Design.* **H. M. Hobart and A. G. Ellis.** (Elect. Rev. 61. pp. 395–397, Sept. 6; 441–443, Sept. 13, and pp. 475–477, Sept. 20, 1907. Ecl. Électr. 53. pp. 161–166, Nov. 2, and pp. 195–198, Nov. 9, 1907.)—The authors develop a method of determining the leading dimensions of a machine so as to secure a design having magnet cores of circular cross-section, a low reactance voltage, a low peripheral speed of commutator, and a low total works cost. The selection of the most suitable design involves the comparison of the above characteristics in a number of alternative designs. The reactance voltage may be easily determined by means of the simple formula previously given by Hobart [Abstract No. 598 (1906)]. Considering the case of a lap-wound armature, the minimum permissible number of poles is first determined by assuming that the amps. per pole do not exceed 250. Reference is then made to one of several groups of curves given by the authors for various speeds and numbers of poles, the abscissa of any point representing the gross length of armature core, and the ordinate the air-gap diam., and, to a different scale, the peripheral speed. Each curve corresponds to a given armature strength in amp.-turns per pole. Each set of such curves (curves A) corresponding to a given number of r.p.m. and number of poles, is intersected by another set of curves (curves B), each passing through points corresponding to the same output. On each group of curves, the points corresponding to designs of such proportions that magnet cores of circular cross-section may be used, are indicated by small circles. The intersection of the curve B corresponding to the given output with the various curves A for the minimum number of poles gives the lengths and diameters for various armature amp.-turns per pole, and from these the number of turns per pole, and that of commutator segments, is at once determined. The procedure is then repeated for two or three numbers of poles higher than the minimum number, by using the groups of curves corresponding to those numbers and the given speed (the authors give in all 21 groups of curves, the speeds being 125, 250, 500, 1,000, and 2,000 r.p.m., and the number of poles 4, 6, 8, 12, and 16). The commutator speed is estimated on the assumption that the width of segment *plus* insulation at the periphery of the commutator is equal to 5 mm., and the total works cost is taken to be proportional to $D(\lambda_g + 0{\cdot}7\tau)$, where $D =$ gap diam., $\lambda_g =$ gross core-length, and $\tau =$ pole-pitch. A comparison of the various alternative designs arrived at by this method enables us to select the most suitable design. A. H.

1281. *Continuous-current Turbo-generators.* **H. I. C. Beyer.** (Elektrotechnik u. Maschinenbau, 25. pp. 743–749, Sept. 29; 768–771, Oct. 6, and pp. 787–792, Oct. 13, 1907.)—These articles contain a review of modern practice in turbo-dynamos, with special reference to details of construction. A common practice in connection with commutating pole windings is to provide a larger number of turns than will actually be required, and then to adjust the ampere-turns to the desired value by means of a German silver shunt. This method has various disadvantages. Owing to the different temperature-coefficients of the winding and its shunt, the fraction of the current shunted does not remain constant, and commutation is unfavourably affected. Further, in view of the very low resistances dealt with, the resist-

ances of the contacts are liable to give trouble; and lastly, owing to the widely different self-inductances of the winding and its shunt, sudden changes of load or short-circuits produce violent temporary sparking, accompanied by great danger of flashing over. A much better plan is to obtain exact adjustment by gradually reducing the air-gap between the commutating pole-shoe and the armature. This is done by making the length of commutating pole so short that the original length of gap is too great to give the desired commutating field. By then slackening the bolts which hold the pole against the yoke-ring, and inserting thin strips of iron between the pole and yoke-ring, the gap is reduced in length until the best results are obtained. The adjustment should be continued until the commutator shows the *smallest temperature-rise*; in no case should the criterion of non-sparking be depended on, as commutation may be far from satisfactory even if there is no visible sparking. In order to counteract armature reaction it is desirable to provide the main poles with several deep slots. The author considers the slotting of the inter-poles with the object of reducing the reactance voltage quite useless. The width of the commutating poles should at least equal that of two teeth and slots, and should preferably be 2½ times the width of a tooth and slot. In the case of machines provided with a compensating winding, the length of the main pole-arc may be about 0·55 of the pole-pitch in small machines up to 100 or 200 kw., and 0·6 to 0·7 of the pole-pitch in larger machines. The length of single air-gap should be about 6 mm. for small machines of about 100 kw., about 8 mm. for machines of medium size, and 10–12 mm. for machines of 1,000 to 1,500 kw. The number of poles is in most cases determined by the permissible voltage between segments, which should not exceed 20 or at most 25. The peripheral velocity of the armature should not exceed 70 m./sec., or at most 80 m./sec. It is sometimes found that in order to avoid an excessive voltage between segments the two-pole type of construction, which leads to a much more expensive machine, must be adopted. In such cases, a 4-pole design may become practicable by doubling the number of commutator segments, the intermediate segments being connected to the joints at the back of the armature winding by means of conductors threaded through the core; the voltage between segments then corresponds to the e.m.f. generated in a half-turn—*i.e.*, in a single conductor. The wedges used for holding the conductors in position consist mostly of well-dried vulcanised fibre or wood. The armature core should be divided into sections each of which is 30 to 50 mm. thick, with ventilating ducts of not less than 8 mm. between them. For the bindings of the projecting ends of the conductors, the author recommends bronze wire 2 mm. thick wound on under a tension which is in the neighbourhood of the elastic limit of the material. Commutators and brush gear are next discussed. Most of the troubles experienced with brushes are due to vibrations caused by the commutator being slightly out of truth. The Westinghouse Co. has experimented with a type of commutator in which the brushes are applied to the plane end-surfaces of the commutator instead of to its cylindrical surface. In this design, the commutator has a number of wide and deep rectangular grooves turned in it, and into each groove is introduced a pair of carbon brushes which press against the plane side surfaces of the groove. In order to secure the necessary mechanical strength, a steel ring is shrunk on over each of the rectangular commutator ridges which separate the grooves. This arrangement is said to have given excellent results, and a commutator of this type is at present being fitted to a 1,000-kw., 600-volt, 1,500-r.p.m. Westinghouse turbo-generator. The armature shaft should be so dimensioned

that the critical speed at which whirling occurs lies sufficiently far outside the usual speed limits; formulæ are given for calculating the size of shaft in various cases. As an illustration of modern turbo-generator design, full particulars are given of a 875-kw., 240-volt, 4-pole, 2,500-r.p.m. machine constructed by the British Westinghouse Co. A. H.

1282. *New Train-lighting Dynamo.* M. Osnos. (Elektrotechn. Zeitschr. 28. pp. 917–918, Sept. 19, 1907. Paper read before the Verband Deutscher Elektrotechniker, Hamburg. Écl. Électr. 53. pp. 166–169, Nov. 2, 1907.) —The principle of the new dynamo invented by the author, and now being manufactured by the Felten and Guilleaume-Lahmeyerwerke, will be understood by reference to the Fig. The dynamo D has its field winding s_1 connected across the brushes *aa* of an exciter E of special design, which is carried on the same shaft as D. The battery B_1 supplies current to the field winding s_2 of the exciter, and to the brushes *bb* which coincide in direction with the main field. The field coil s_3 is intended to enable the armature cross-flux of the exciter to be adjusted to the desired value. The e.m.f. generated between the brushes *bb* by the rotation of the



armature in the cross-flux opposes the battery e.m.f., so that with increasing speed the main field of E is greatly weakened, with the result that the p.d. across the coil s_1 will decrease, and by suitable adjustment (once for all) of s_3 the p.d. of the main dynamo D may be rendered practically constant at all speeds above a certain minimum. It will further be seen that since a reversal of the direction of rotation reverses the current through s_1, the polarity of the main dynamo D is independent of the direction of rotation. Various modifications of this arrangement are described. [See also Abstract No. 898 (1906).] A. H.

1283. *Effect of Commutating Poles on Dynamo Design.* F. H. Page and F. J. Hiss. (Inst. Elect. Engin., Journ. 39. pp. 570–599; Discussion and Communications, pp. 599–616, Sept., 1907. Elect. Engin. 39. pp. 721–725, May 24; 757–761, May 31, and pp. 795–796; Discussion, p. 797, June 7, 1907. Electrician, 59. pp. 304–306, June 7; Discussion and Communications, pp. 345–346, June 14, 1907. Abstract.)—After a brief general consideration of the heating and commutating limits, the authors explain the methods employed by them in arriving at the dimensions of commutating poles and determining their windings. The advantages resulting from the use of commutating poles consist partly in a reduction of the works cost, partly in improvements in the working qualities of the machines. A reduction of the works cost is rendered possible owing to (*a*) the higher permissible armature reaction; (*b*) the smaller air-gap; (*c*) the possibility of increasing the length and reducing the diam. of the armature; (*d*) the smaller commutator. The working qualities of the machine will be improved by reason of (*a*) the smaller number of commutator segments, and consequent reduced trouble due to high micas or bars; (*b*) better commutating qualities;

(*c*) smaller amount of attention required by commutator and less frequent brush renewals. The authors express the opinion that if the above advantages are to be fully realised, a complete rearrangement of the ordinary designs (without interpoles) becomes necessary; owing, however, to the extra labour cost entailed in fitting commutating poles to *small* machines, and the small amount of space available between the main poles in such machines, the authors think that commutating poles should only be used in machines of over 40 or 50 kw. Modern practice in commutating pole design is illustrated by descriptions of typical forms of machines provided with commutating poles. In the *discussion*, **F. E. Ussing** and **A. G. Ellis** expressed the opinion that the authors had gone too far in recommending the general adoption of interpoles; these should only be resorted to in cases where the ordinary design becomes impracticable. **R. Pohl**, on the other hand, upheld the authors' view of the matter. A. H.

1284. *Rapid Method of finding the Efficiencies of Electric Machines.* **R. Rougé.** (Rev. Électrique, 8. pp. 175–180, Sept. 30, 1907.)—In practice the efficiency of electrical machines is generally determined by the manufacturers by means of the method of "separate losses." It is generally assumed that the losses can be divided into two parts, one of which is constant at all loads and the other varies as the square of the current. If C denote the current the author denotes the fractional loss $(A + BC^2)/EC$ by δ, where A and B are constants and E the terminal p.d. The fractional efficiency η is therefore equal to $1/(1 + \delta)$. The minimum value δ_1 of the fractional loss occurs when $C_1 = \sqrt{A/B}$, and this value makes η a maximum. It will be noticed that the *shape* of the curve for δ is the same, on the given assumptions, for all machines. It is therefore only necessary to know the maximum efficiency, and therefore the minimum value of δ in order to construct the efficiency curve. To assist in the calculation of points on this curve the author calculates first a table giving the values of δ/δ_1 for values of C/C_1 ranging from 0·10 to 2·00. He next gives a table from which η, which equals $1/(1 + \delta)$, can be found at once when δ is known. In the case when the efficiencies at two loads are given and the maximum efficiency is not known it can generally, in practice, be evaluated, since the form of the efficiency curve is known. In a third table he tabulates various ratios of δ_1/δ_2 to assist in this computation. He concludes that it is quite unnecessary to give complete efficiency curves, as the curve is completely determined when we know the maximum efficiency. When direct efficiency tests of machines can be made, calculations of the theoretical efficiency curves are still useful. For instance, in induction apparatus a wide divergence between the calculated and observed values indicates excessive magnetic leakage, and in synchronous motors indicates that the machine approaches too close to the zone of unstable working. Useful full-page diagrams are given, from one of which the efficiencies at all loads can be read off directly when the maximum efficiency is given, with sufficient accuracy for practical work, and from the other the maximum efficiency can be found at once when the efficiency at a given load and at half that load are known. A. R.

1285. *Effect of Damping on Hunting of Paralleled Alternators.* **F. Emde.** Elektrotechnik u. Maschinenbau, 25. pp. 721–728, Sept. 22, 1907. Écl. Électr. 53. pp. 128–131, Oct. 26, 1907.)—Görges was the first to point out [Abstract No. 556 (1904)] that the fluctuations in the power of a paralleled alternator are not always reduced by the addition of

damping devices. Such devices may, in fact, increase the fluctuations if the frequency of the free oscillations of the magnet wheel is below 0·707 of the frequency of the forced oscillations. The author, after referring to the investigations of Kapp [Abstract No. 1085 (1899)] and Rosenberg [Abstract No. 2586 (1904)], deals with the problem partly by an analytical, partly by a graphical method. He arrives at the conclusion that when the non-uniformity of the driving torque exceeds a certain limit damping devices become useless, the only remedy being to increase the moment of inertia of the magnet-wheel.

A. H.

1286. *Load Characteristics of Dynamos and Motors.* C. F. Guilbert. (Écl. Électr. 52. pp. 361–366, Sept. 14, and pp. 397–405, Sept. 21, 1907.)—The *characteristic equation* of a direct-current machine is defined as—

$$f(\omega, V, I, i) = 0,$$

where ω denotes the angular velocity, V the p.d. at the terminals, I the armature current and i the exciting current. In general these four quantities are independent, and in practice the equation is studied by finding "characteristic" curves showing the relation between two of the quantities when the other two are maintained constant. In most tests the angular velocity is kept constant. The characteristics can thus be classified as follows. 1. Characteristic at constant current (I). This includes the open-circuit characteristic for which $I = 0$. 2. Characteristic at constant voltage (V). 3. Characteristic at constant excitation (i). If we vary the angular velocity (ω) we get three new groups, but the only case of interest in practice is when I and i are constant—*i.e.*, how V varies with ω at constant excitation and current. For series machines we have $i = I$, for shunt $i = aV$, where a is a constant; for compound, $i = aV + \beta I$. The characteristics at constant speed reduce, therefore, to the curve $F(V, I) = 0$—*i.e.*, we have only one characteristic instead of three. With series machines running at variable speed (Thury system) we have for $i = I =$ constant, the variable speed characteristic mentioned above. We have also the characteristic of the pressure at no load for separate excitation. For motors, the speed of which is variable, we have, in addition to three groups of characteristics the same as those for generators, the three following groups. 1. Speed characteristic in terms of the pressure of a motor having constant excitation and supplied with constant current. The only practical case is the series motor for which $i = I$. 2. Speed characteristic, in terms of the current taken, of a motor working at constant pressure and excitation. The shunt motor is a particular case. 3. Speed characteristic in terms of exciting current when the power absorbed is constant (unpractical case). With series, shunt or compound winding and at variable speed the equation $f(\omega, V, I) = 0$ includes finally the following groups: (1) Speed characteristics of motors supplied at constant current, and (2) speed characteristics at constant pressure. It is not necessary to make a complete experimental study of each of these groups of characteristics. The author proceeds to show how one constant and one variable speed characteristic determines all the others. He first gives a *résumé* of the work done by Potier, Picou, and Guilbert on the effects of armature reaction. He shows how Potier's well-known method for studying the characteristics of alternators can be applied to direct-current machines. This follows since the characteristics at constant current are sensibly parallel to the characteristics on open circuit. If P, P′ be corresponding points on

these curves and PN, P'N be lines parallel to the axes, the triangle PNP' is constant. This is called the Potier triangle. The author also shows how Picou's graphical construction can be made more general. He proves that in dynamos in which the armature and excitation current are maintained constant, and the brushes are far from their neutral position, the voltage drop between no load and any given load is sensibly proportional to the angular speed. This theorem is true whether the iron in the field magnets be saturated or not. On the other hand, when the brushes are near their neutral position, the voltage drop between no load and full load is sensibly independent of the speed at which the machine is running. When the armature current is varied it is shown that if the position of the brushes and the exciting current remain the same the voltage drops are sensibly proportional to the armature current. Finally, when the excitation is varied, then, for the same speed, the same armature current and the same position of the brushes, the voltage drops are sensibly independent of the excitation. Algebraical formulæ are found which enable the voltage drops, &c., under one set of conditions to be calculated readily from the characteristic curves found for other values of the variables. In the examples given the values of the variables both when the brushes are in the neutral position and when they are far from it are found. The author, however, emphasises that in modern machines we can apply with sufficient accuracy for practical purposes, the method based upon the independence of the voltage drop and the angular speed. A. R.

1287. *Load Characteristics of Dynamos and Motors.* C. F. Guilbert. (Écl. Électr. 53. pp. 37–44, Oct. 12, and pp. 78–80, Oct. 19, 1907.)—In a former paper [see preceding Abstract] direct-current machines were considered. In the characteristics of alternating-current machines the power-factor introduces a new variable. A characteristic can be obtained by keeping constant any three of the variables in the equation $\Phi(\omega, V, A, \cos\phi, C) = 0$, where ω is the angular velocity, V is the voltage, A the armature current, $\cos\phi$ the power-factor, and C the exciting current. In practice the case of $\cos\phi$ variable is not considered, but in the case of synchronous machines we have V curves for which V and $q\mathrm{VA}\cos\phi$ are constant. The practical problem simplifies to the consideration of four groups of curves, and it is therefore simpler than for direct-current machines. The reaction of the armature is practically identical with that in direct-current machines, as lagging and leading currents produce effects analogous to shifting the brushes on the commutator. The author proves that if the resistance of the armature is negligible compared with the e.m.f. due to the magnetic leakage of the armature, the p.d. at the terminals as well as the voltage drop are proportional to the speed whatever the relative importance of the lag or lead, provided that the excitation, the current in the armature, and the lag of this current with regard to the e.m.f. remain the same. He shows that for the same velocity and the same exciting current the voltage drops, provided they be not too different, are proportional to the wattless components of the current in the armature. It is also shown that if $\cos\phi$ be less than 0·5 the voltage drops are practically independent of the excitation and approximately proportional to the wattless components of the current, provided that the velocity and the current in the armature remain constant. The three theorems given above are applied to the various types of characteristics, and formulæ are obtained by means of which they may be corrected for variations in the values of the angular velocity, excitation, &c. Finally,

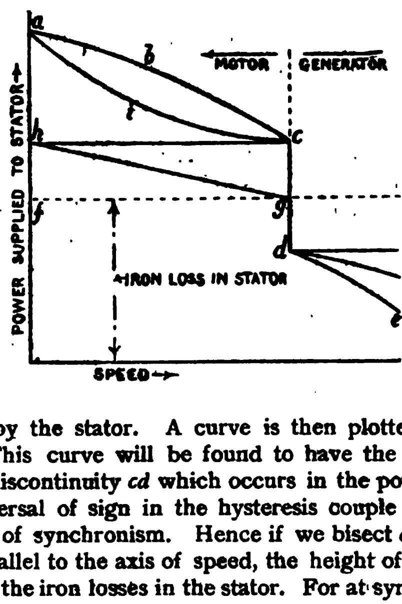
formulæ are obtained for the induction motor. Numerous practical examples are given to show how the formulæ facilitate the testing of machines. They are also of use in predetermining the working of a machine under given conditions. A. R.

1288. *Bipolar Motor Construction for Locomotives.* (Electrical World, 50. p. 597, Sept. 28, 1907.)—In connection with bipolar motors for locomotives it has been found advantageous to make use of the locomotive frame for carrying the magnetic flux. In order to keep down the required increase of metal in the frame to the smallest possible amount, A. F. Batchelder has patented the following type of construction. Each of the four driving axles carries two independent armatures, one at each end of the axle, with a sufficient clearance space between them. The magnetic circuits of the motors are connected in series with each other so as to form a single circuit of rectangular form. The longer sides of this rectangle are parallel to the rails, and each consists of the four armatures, the two pole-pieces between the intermediate armatures, and the two pole-pieces outside the extreme armatures. The only portions of the locomotive frame which require thickening to convey the flux are the cross-bars connecting the end pole-pieces and forming the shorter sides of the rectangular magnetic circuits (U.S. Pat. 865,988). A. H.

1289. *New Induction Motor.* L. J. Hunt. (Inst. Elect. Engin., Journ. 39. pp. 648–667; Discussion, pp. 668–677, Sept., 1907. Paper read before the Manchester Local Section. Elect. Engineering, 1. pp. 545–546, March 28; 606–607, April 4, and Discussion, pp. 629–631, April 11, 1907. Abstracts in Electrician, 59. pp. 55–57, April 26, 1907. Elect. Rev., N.Y. 50. pp. 711–718, May 4, 1907.)—The motor described possesses all the characteristics of the ordinary type of slip-ring induction motor, but differs from it in the arrangement of the windings. These are arranged to permit of the starting or regulating resistances, being connected with the stator windings instead of with the slip-rings in the ordinary manner. The machine is a type of cascade motor having two magnetic field systems superimposed on one another in the same core body. The second field has its origin in the rotor, and consequently induces secondary currents in the stator windings. Instead of connecting the rotor and stator windings in the ordinary cascade manner, the same effect may be obtained by coupling the two rotor windings and connecting the starting or regulating resistances with the stator windings of the second motor. Slow-speed motors have been built in this way. If the two motors are wound for the same number of poles, and have the same electrical characteristics, the maximum energy current which they will take from the line when connected in cascade will be a little less than half that taken by one motor when working independently. The new motor which has been developed by the Sandycroft Foundry Co. has two stator windings wound for dissimilar numbers of poles. The numbers of poles are so chosen that when divided by their highest common factor we get an even number in one case and an odd number in the other. The stator has a single winding provided with terminals for connecting with the supply mains, and with tappings which are connected in pairs through resistances whilst starting or when rheostatic speed control is desired and are short-circuited at the normal speed. The rotor, unless designed to run at more than one efficient speed, is provided with a short-circuited winding without slip-rings. By a

suitable change-over switch the number of poles can be altered and so several effective speeds obtained. Complete diagrams are given of the windings and various methods of connection are discussed. **M. B. Field** points out that in a cascade system the two machines must be coupled mechanically as well as electrically, and thinks that a "one-speed" machine constructed on the cascade system merely to eliminate the rotor's slip-rings is a clumsy arrangement. The **Author** replies that the machine as now developed is as efficient as a slip-ring motor and is cheaper to build. A. R.

1290. *Analysis of Losses in Induction Motors.* **W. Linke.** (Elektrotechn. Zeitschr. 28. pp. 964–967, Oct. 8, 1907. Écl. Électr. 53. pp. 196–208, Nov. 9, 1907.)—The characteristic feature of the author's method is that it allows of a separation of the pulsation losses in the teeth (due to the passage of the rotor teeth across those of the stator) from the frictional losses. The motor to be tested is coupled to an auxiliary motor, by means of which the speed of the *open-circuited* rotor of the main motor is varied, and a number of readings is obtained connecting the rotor speed with the



power absorbed by the stator. A curve is then plotted connecting these two variables. This curve will be found to have the shape *abcde* shown in the Fig. The discontinuity *cd* which occurs in the power at synchronism is due to the reversal of sign in the hysteresis couple as the rotor passes through the speed of synchronism. Hence if we bisect *cd* at *g*, and through *g* draw a line parallel to the axis of speed, the height of this line above the axis will represent the iron losses in the stator. For at synchronism the stator field exerts no couple on the rotor, both the torque due to hysteresis and that due to eddy currents vanishing at this speed; thus the stator transmits no power to the rotor, and the entire power supplied to the stator must therefore represent the stator loss, which is practically its iron loss. Again, just below synchronous speed there is no appreciable eddy-current loss, hence *gc* represents the power transmitted from the stator to the rotor by the hysteresis couple; this power is, just below synchronous speed, practically all transformed into useful mechanical power. Now since the hysteresis torque remains constant at all speeds, the power transmitted from stator to rotor on account of hysteresis will remain constant from zero speed up to synchronism, and will be represented by the distance between the two lines *fg* and *hc* in the diagram. If the rotor is at rest it is clear that the power *fh* will all be dissipated; at any intermediate

speed the rotor hysteresis power will be partly usefully transformed, the fraction so transformed being given by the product of the hysteresis couple into the speed, and partly wasted. Since the fraction usefully transformed is proportional to the speed, it will be represented by the ordinates included between *hc* and the diagonal *hg*, the ordinates between *hg* and *fg* representing the power dissipated by hysteresis. The ordinates included between *hc* and *abc* represent the power due to eddy currents in the rotor. Now the eddy-current loss varies as the square of the slip, so that if we draw the parabola *cia* passing through *c* and *a* and touching *hc*, the ordinates included between *hc* and *cia* will represent the eddy-current loss in the rotor; while those included between *aic* and *abc* will represent the useful mechanical power supplied by the stator to the rotor through the medium of the eddy-current torque. The moment of inertia of the rotor is next determined; the method recommended by the author for this purpose consists in mounting the rotor in ball bearings, loading it with a heavy pendulum whose moment of inertia has been previously calculated, and finding the moment of inertia of the rotor from the period of vibration of the system and the period of the pendulum when used alone. Two retardation curves, starting with speeds considerably above synchronism, are then determined, one being taken with the stator fully excited (rotor as before being open-circuited), the other with the stator switched off. The former curve is supplemented by an acceleration curve, the open-circuited rotor running up to a certain speed under the influence of the hysteresis and eddy-current torques. From these retardation and acceleration curves may be deduced another set of curves, connecting the speed with the power given out or absorbed by the rotor. Let f = power absorbed by friction; t = high-frequency or pulsation loss in the teeth; u = useful power due to hysteresis and eddy-current torques. Then if w = total power supplied by stator to open-circuited rotor at any speed, $w = f + t + u$ so long as the speed is below synchronism, and $w = f + t - u$ if the speed is above synchronism. Thus the power-speed curve obtained from the retardation curve with the stator excited will exhibit a discontinuity at synchronism. Now if from this curve we subtract the sum of the ordinates lying between *hg* and *hc*, and *aic* and *abc* in the Fig., we obtain a curve connecting $f + t$ with the speed. Finally, if we subtract from this latter curve the ordinates of the power-speed curve corresponding to the unexcited stator (this curve being the f-speed curve), we obtain the t-speed curve. A complete analysis of the no-load losses may thus be effected. From tests carried out on a large number of induction motors, the author finds that the pulsation loss in the teeth is, on the average, about 20 per cent. of the stator iron loss, but cases occur in which it may be as high as 50 per cent. of this loss.

A. H.

1291. *Heyland's Method of Starting and Controlling the Speed and Power-factor of Induction Motors.* **F. G. Wellner.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1420–1428, Sept. 7, and pp. 1708–1709, Oct. 26, 1907. Paper read before the Dresdener Elektrotechn. Verein, June 27, 1907.)—Heyland has recently devised the following method of starting an induction motor, which does not involve the loss of large amounts of energy in a starting resistance, while enabling the motor to exert a very powerful starting torque. The rotor of the motor is provided with slip-rings, and is connected to the stator of an auxiliary induction motor which is mechanically coupled to a separately excited continuous-current generator. The main motor is itself mechanically coupled to another separately excited continuous-current machine. The armatures

of the two continuous-current machines are electrically coupled without any resistance in their circuit. When the field of the generator belonging to the auxiliary set is open, and the stator of the main motor is across the supply mains, the auxiliary motor-generator set runs at its highest speed, the main motor being at rest. In order to start the main motor the field of the auxiliary generator is closed and the exciting current gradually increased. By suitably varying the exciting current the total torque exerted by the main motor and the continuous-current motor coupled to it may be maintained constant during the acceleration period. Should the main motor be required to run at full speed for a considerable period it is best to short-circuit its rotor and to open the field circuits of the continuous-current machines. If then it is required to stop the main motor, its rotor is once more connected across the stator of the auxiliary motor, and the field of the machine coupled to it is regulated so as to make it absorb power from the other continuous-current machine [a similar arrangement has been patented by the Siemens-Schuckert Works, D.R.-P. 156,860]. The auxiliary motor-generator set may be replaced by a converter, and may with advantage be in some cases fitted with a flywheel. The author points out that this arrangement has certain advantages over the Ilgner system [Abstract No. 1084 (1908)], the auxiliary motor-generator set being smaller and the use of a much lighter flywheel being rendered possible on account of the much larger speed fluctuations of the auxiliary set. A. H.

1292. *Fractional Pitch Windings for Induction Motors.* **C. A. Adams, W. K. Cabot, and G. Æ. Irving, Jr.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 1245–1268, Aug., 1907.)—In this paper the effect on the leakage reactance of the use of fractional-pitch windings is considered. The authors describe a method developed by theory and experiment, by means of which the leakage reactance may readily be calculated for any coil pitch, and is applicable to two- and three-phase slip-ring motors. The total leakage reactance is the sum of four components, viz., slot, tooth-tip or zigzag, coil-end, and belt leakage reactances. The values of the component leakage reactances corresponding to any coil pitch are obtained by the aid of correction coefficients, termed by the authors pitch factors. Several sets of theoretically deduced and experimental curves are given, connecting the pitch factor with the coil pitch expressed in terms of the full coil pitch. To sum up, the authors find that by the use of fractional-pitch windings, a reduction in the several component leakage reactances is effected. They also mention that its use effects a reduction in the overall length of the motor, and in some cases a considerable gain in the convenience of winding as well as a saving of space. Further, a decrease in the exciting reactance is effected, thus permitting higher densities in all parts of the magnetic circuits and higher exciting current for the same voltage. Finally, there is given a table showing the comparative constants for a three-phase three-speed induction motor.

H. M. H.

1293. *Artificial Cooling of Induction Motors.* (Electrical World, 50. pp. 610–611, Sept. 28, 1907.)—C. P. Steinmetz has patented a method of artificially cooling the squirrel-cage winding of an induction motor for driving rolling-mills. The conductors consist of piping connected to hollow end-rings. By means of a suction pump water is drawn through the conductors; owing to the partial vacuum, a leaky joint merely admits air instead of allowing water to escape. The rotor resistance is so high that

maximum torque occurs at a slip of about 200 per cent., allowing of very rapid reversals of rotation. Owing to the artificial cooling, the rotor may be made extremely small, and will have a correspondingly small moment of inertia (U.S. Pat. 865,617). A. H.

1294. *Single-phase Induction Motor.* (Elektrotechnik u. Maschinenbau, 25. p. 690, Sept. 8, 1907.)—The stator is provided with a two-phase winding. Phase I. is connected in series with the primary of a transformer having a ⊔-shaped core, the primary being placed on one limb of the core only. The other limb carries the secondary, which is across phase II. of the stator winding. The transformer core is provided with a movable yoke which may be made to bridge across the tops of the vertical limbs of the core. At starting this yoke is withdrawn, so that the magnetic leakage is considerable, and there is a large phase-displacement between the currents in the two phases of the stator. The movable yoke is gradually lowered and finally made to bridge across the core. The above design has been patented by the Felten and Guilleaume-Lahmeyerwerke (D.R.-P. 182,060). A. H.

1295. *Air-blast* v. *Oil-insulated Transformers.* M. A. Sammett. (West. Electn. 41. pp. 220–221, Sept. 21, 1907. From paper read before the Canadian Elect. Assoc., Sept. 11, 1907.)—It is stated by the author that of the various types of transformer, the natural draught type is entirely obsolete in America. The smaller sizes are almost invariably of the oil-insulated type, while the larger ones are either of the air-blast or of the oil-insulated water-cooled type. The great objection to air-blast transformers is the ease with which they accumulate dust; the air-passages frequently become blocked, and the temperature may reach a dangerous point in the upper portions of the coils. There is also some danger connected with the use of compressed air for blowing out the dust, as unless the air is perfectly dry moisture may get into the coils, damaging the insulation and causing a burn-out. A further objection to air-blast transformers is the ease with which flames started in one transformer are carried to its neighbours through the air-ducts. These defects are largely removed in the oil-insulated water-cooled type, which possesses the further great advantages of being able to withstand excessive overloads (transformers of this type have been known to operate satisfactorily with the oil at 200° C.), and of greater dielectric strength. The fire risk due to the use of oil in the transformer tank is, according to the author, practically nil. The only weak points of this type are (1) the possibility of water getting at the winding if a leaky water coil is used, or if, when the transformer is not in use, the coil is left filled with water during severe weather, and is burst by frost; (2) the danger of a decomposition of the oil at high temperature, with the formation of a thick non-conducting deposit. A. H.

1296. *Improvements in Single-phase Commutator Motors.* (Elektrotechnik u. Maschinenbau, 25. p. 700, Sept. 8, 1907.)—The following improvements have all been patented by the Felten and Guilleaume-Lahmeyerwerke. In order to secure large starting torque with high power-factor under normal running conditions in an Eichberg-Latour motor, the "short-circuit" brushes are connected across the secondary of a transformer whose primary is in series with the stator. The stator winding itself may form the primary, the secondary being embedded in slots in the stator core. The secondary is provided with taps so that the number of secondary turns may be gradually reduced, and the short-circuit brushes finally closed on themselves. At

starting the full number of turns in the secondary is in use, and a large starting torque is obtained. As the motor gains speed the secondary turns are gradually cut out, and on short-circuiting the short-circuit brushes a high power-factor is obtained (D.R.-P. 182,061). The second improvement relates to a motor whose stator winding may be changed from an 8-pole one for a low speed to a 4-pole one for a high speed. The armature of this motor is provided with two independent windings, an 8-pole and a 4-pole one, each having its own commutator, the segments of the one commutator being sandwiched in between those of the other. On this compound commutator are placed 8 brush sets, divided into two groups of 4 alternate sets. Each brush is of sufficient thickness to be in connection with both windings. The sets of the first group are all connected together; those of the second group are in connection with a throw-over switch. If by means of this switch all the brushes are connected together, forming a general short-circuit, the motor runs at half speed in an 8-pole field as a repulsion motor; on altering the field to a 4-pole one, and at the same time connecting the brushes of the second group in series with the stator winding, the speed is doubled, the motor now running as a compensated conduction motor (D.R.-P. 188,812). The third improvement relates to a method of speed control in motors of the Latour-Eichberg type. Between the end of the stator winding and the exciting brush to which it is connected is introduced the primary of a transformer, the junction of the primary and the exciting brush being connected to one end of the secondary. The remaining end of the secondary may, by means of a switch, be connected to the remaining exciting brush. By closing or opening this switch the exciting current of the motor may be varied within wide limits *without opening the main circuit* (D.R.-P. 185,204). A. H.

1297. *Parallel Connection of Three-phase Transformers.* G. Stern. (Elektrotechn. Zeitschr. 28. pp. 981–982, Oct. 10, 1907. Elect. Rev. 61. p. 880, Nov. 15, 1907.)—Three-phase transformers can only be paralleled on both sides if the phase relations of the primary and secondary voltages are identical. Imagine two exactly similar transformers, with similarly connected Y-windings on primary and secondary sides. Such transformers may be paralleled on both sides. But if the connections of all the secondary coils of one of the transformers be reversed, parallel connection becomes impossible. Similarly, two transformers having Δ-connected primary and secondary coils, with connections similarly arranged in every respect, may be paralleled. But a cyclical interchange of the secondaries in one will render parallel operation on both sides impossible. The author introduces the term "network angle" to denote the least angle of phase-difference between a primary and a secondary e.m.f. vector. The network angle may assume the values 0°, 30°, 60°, and 90°, according to the mode of connection of the windings, and a necessary condition for parallel operation of transformers on both sides is equality of the network angle. At present practice has not become standardised with respect to the network angle, with the result that the ordering of new transformers involves a lot of troublesome correspondence. The author suggests that the network angle should be marked on the output plate of the transformer. A. H.

1298. *Improvements in Motor Generators supplied from Traction Circuit.* (Engineering, 84. p. 448, Sept. 27, 1907.)—The following devices, both due to H. Leitner, have for their object the better speed regulation of motor-

generator sets when supplied with current from circuits of variable voltage, such as traction circuits. In the first arrangement (Brit. Pat. 18,782A of 1906), the shunt winding of the motor is connected in series with a source of counter-e.m.f., such as a secondary battery. With the connections so arranged, it is evident that a given percentage increase in the supply p.d. will produce an equal percentage increase in the brush p.d., but a much *larger* percentage increase in the p.d. across the shunt. The one effect counteracting the other so far as speed variations are concerned, it is evident that by a suitable choice of opposing voltage in the shunt circuit the speed may, within certain limits, be rendered independent of voltage fluctuations in the supply circuit. In the second method (Brit. Pat. 18,782B, of 1906), there is an additional field winding on the motor which is connected across the armature of a small auxiliary generator, the field of this generator being supplied from the variable voltage circuit. The generator is driven by a small auxiliary motor. A rise in the supply p.d. results in an increase of the motor field strength, the speed being thereby maintained practically constant. The field of the main motor must be well below saturation. A. H.

REFERENCES.

1299. *Tests of Carbon Brushes.* (Soc. Int. Élect., Bull. 7. pp. 433–476, Aug.–Sept.–Oct., 1907.)—This article contains an account of the results of various tests intended to render possible the identification of the different brands of carbons used in brushes. The tests include the determination of apparent density, porosity, tensile and compressive strength, abrasion, electrolytic behaviour as anode, resistivity and temperature coefficient, contact potential drop, coefficient of friction, percentage of ash on ignition of specimen, and microscopic examination. A. H.

1300. *Commutating Poles.* **H. Zipp.** (Elektrotechnik u. Maschinenbau, 25. pp. 687–692, Sept. 8, 1907. Écl. Electr. 53. pp. 20–21, Oct. 5, 1907.)—The author explains in a simple manner, mainly by the aid of graphical methods, the advantages to be derived from commutating poles when fitted to either generators or motors. A. H.

1301. *Commutating-pole Railway Motors.* **E. H. Anderson.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 1265–1275, Aug., 1907. Street Rly. Journ. 29. pp. 1142–1145, June 29, 1907. West. Electn. 41. pp. 169–170, Aug. 31, 1907. Abstract.)—The theory of commutating poles and the advantages offered by them are briefly discussed. In addition to the advantages enumerated in Abstract No. 982 (1907), the author claims for commutating-pole motors the following: Possibility of successfully using higher voltages; greater facility in design of large motors, especially as regards commutation; and possibility of increasing service capacity of motors by the use of artificial cooling devices. A. H.

1302. *Circle Diagram for Synchronous Motor.* **A. S. McAllister.** (Electrical World, 50. pp. 370–374, Aug. 24, 1907. Electrician, 60. pp. 124–126, Nov. 8, 1907. Abstract.)—The author establishes a diagram in which the locus of the extremity of the armature current vector with varying load at constant excitation is a circle. This diagram enables the V-curves of the motor to be deduced in a simple manner. The diagram is based on the assumption of a constant "synchronous impedance" for the armature. A. H.

1303. *Hunting in Rotary Converters.* **N. G. Meade.** (Electrical World, 50. pp. 226–228, Aug. 3, 1907.)—A graphical description of the theory of the phase swinging of a set consisting of a rotary converter and generator is given. The remedial effects produced by dampers are also discussed. A. R.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

1304. *Cost of Steam and Hydro-electric Power.* **W. O. Webber.** (Eng. Mag. 33. pp. 889–893, Sept., 1907.)—The author criticises omissions from H. v. Schon's estimates of costs [see Abstract No. 1088 (1907)], and gives data of his own. A 10-h.p. steam plant in actual practice cost £474, and a 80-h.p. plant £2,896, including land and buildings, and all accessories. With coal at 10s. the working costs per h.p.-hour ranged from 2·38d. with 10 h.p. to 1·1d. with 80 h.p.; with coal at 18s. these figures became 3d. and 1·46d. respectively. One steam h.p.-year cost £16 16s. with coal at 16s. in an 80-h.p. plant, the installation costing £35 per h.p. Hydro-electric power cost about £2 per h.p.-year at the waterfall, and £2 11s. 2d. at a distance of 20 miles. Data are given for the average flow of New England streams. A. H. A.

1305. *Utilisation of Test-room Power.* **E. Kaufmann.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1628–1630, Oct. 12, 1907. Paper read before the Mannheim Bezirksverein.)—The author draws attention to the large waste of power which is generally allowed to go on in testing prime movers of various types. This waste could easily be arrested by abandoning the use of absorption dynamometers, and loading the prime mover under test by means of an asynchronous generator which delivers power to the network supplying the works motors. Such a generator is very simple to deal with, as there are no commutator or paralleling troubles, and it furnishes an ideal brake. A. H.

1306. *Earthing Neutral of Three-phase Systems.* **P. M. Lincoln, G. I. Rhodes, F. G. Clark.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 1433–1443; 1445–1450, and pp. 1451–1457, Sept., 1907. Elect. Rev., N.Y. 51. pp. 684–687, Oct. 19, 1907. Abstract.)—The advantages of earthing the neutral are thus summarised by Lincoln: (1) The potentials of the conductors are maintained at a constant value; (2) electrostatic disturbances in neighbouring circuits are reduced; (3) the earth will automatically act as a conductor when one of the line wires breaks down if the neutrals at both ends of the transmission line are earthed; (4) the condenser currents of the three phases will be equal, tending to preserve a balance of voltages. The disadvantages are that a single earth will disable part or the whole of the system, and that it is difficult to secure a good earth connection. The introduction of resistance into the earth connection to some extent reduces the advantages of earthing, but, on the other hand, it prevents an unnecessarily great strain on the circuit-breakers which are called upon to interrupt the current, and also prevents the phase distortion and excessive voltage drop which may cause synchronous apparatus on the line to drop out of step. The author suggests using a resistance which will allow not more than three times the full-load current to flow through the armatures of the generators, but which is low enough to cause the heaviest circuit-breaker to act with certainty. Rhodes gives an account of experiences on the Interborough Rapid Transit Co.'s system [Abstract No. 1327 (1906)]. Although the number of burn-outs since earthing the neutral has not decreased, the troubles attending such burn-outs have

been greatly reduced, and the reliability of operation greatly increased. Clark points out that in the case of generators whose coil-ends are insufficiently braced a resistance in the earthing connection is necessary in order to prevent damage to the generators. He, however, strongly recommends omitting the resistance in all cases where the circumstances allow of this being done. A. H.

1307. *Method of finding Insulation Resistance of Network during working.* **D. Shirt.** (Elect. Rev. 61. pp. 598–599, Oct. 11, 1907. Écl. Électr. 53. pp. 173–174, Nov. 2, 1907.)—The method described by the author does not necessitate the removal of the earthing connection. By means of a suitable ammeter the current i_1 flowing through the earthing connection is noted when the resistance of this connection is r_1. The resistance of the connnection is next altered to r_2, and the new value of the current i_2 is noted. The insulation resistance F of the network may then be calculated by means of the formula $F = (r_2 i_2 - r_1 i_1)/(i_1 - i_2)$. **F. C. Raphael** (Ibid. p. 637, Oct. 18) points out that Shirt's method closely resembles that employed in Raphael's test. A. H.

1308. *Wood Pole Line Construction.* **A. B. Lambe.** (Canad. Elect. News, 17. pp. 278–280, Sept., 1907.)—The author states that a three-phase line of No. 6 wire will carry 100 kw. 0·83 mile with a loss of 10 per cent., the supply pressure being 1,000 volts, and the power-factor 85 per cent. He then discusses in great detail the construction of pole lines. Creosoting is not used in the United States; the poles last on the average 10 to 12 years. They are spaced at 100 to 150 ft. centres, and a 30-ft. pole, 11 in. diam. at the butt, set 5 ft. deep, will stand a side strain on the top cross-arm of 2,500 lbs. Details of poles, cross-arms, and pins are given. Porcelain or glass insulators are used up to 12,000 volts, porcelain alone for higher pressures. The arcing distance is the shortest distance from the edge of one petticoat to the nearest point on the next or to the pin, and is reckoned to stand 10,000 volts per in.; the permissible line pressure is 60 to 75 per cent. of the value so obtained. Good porcelain will stand 88,000 volts per ½ in. thickness without puncture. The smallest copper conductor used is No. 8 B. & S. All secondaries should be thoroughly earthed. Data are given for determining the proper sag and tension, and the mode of guying poles (which must be done before the conductors are strung) is explained. Particulars are also given of the fixing of arc and incandescent lamps and transformers on poles. Experiments are being made with horn lightning arresters at each insulator and with electrolytic arresters. Earths must be well made to ensure permanency. Power lines need not be transposed, but telephone wires must be. The whole line construction must be of the very best if reliability is to be secured. A. H. A.

1309. *Line Constants and Abnormal Phenomena of Transmission Lines.* **E. J. Berg.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 1409–1424, Sept., 1907.) —The author gives formulæ for calculating the inductances and capacities of transmission lines. For transmission lines working at 30,000 to 100,000 volts, and conductors from 0·25 to 1 in. in diam., the average values of inductance and capacity per mile may be taken as 1·75 millihenrys and 0·0165 mfd. respectively, these values being correct to within 15 per cent. in all practical cases. The abnormal voltages and currents at the opening or closing of a transmission line circuit, the abnormal current rushes and local voltage

stresses in a transformer at the instant of connection, and the behaviour of a non-earthed system, are next discussed. As regards the question of earthing the neutral, the author strongly condemns the use of reactance in the earthing connection, favours the use of resistance in systems up to 15,000 or 80,000 volts, but in the case of still higher voltages recommends a dead earth on the neutral, to avoid any chance of a rise of potential on the line wires above the limit of safety. A. H.

1810. *Concrete Poles.* (Electrical World, 50. pp. 615–616, Sept. 28, 1907.) —These poles, the invention of W. M. Bailey, are reinforced by four or more twisted metal rods equally spaced inside the concrete, and spiral binding wires round the rods, also inside the concrete. The poles are of square section, with the corners bevelled off, and tapering upwards; they are made *in situ* by means of a form or mould, inside which the reinforcing metal rods and wires are placed, and the concrete poured over them. They are claimed to withstand a greater strain than a cedar pole of the same dimensions, also that every pole is a lightning rod, and not only protects itself from being shattered by lightning, but is a safeguard to the instruments and machinery at each end of the line. Steps and holes for bolts are easily made when the concrete is plastic. After the concrete is poured into the forms the latter can be removed in 8 or 4 days, and the pole left to season for about 8 weeks, when it will be ready for use. E. C. R.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

1811. *Simplon Tunnel Locomotives.* G. Jacoby. (Elektrische Kraftbetr. u. Bahnen, 5. pp. 501–507, Sept. 14, 1907.)—Some details are given of the motors driving the Simplon Tunnel locomotives [Abstract No. 471 (1906)]. These motors are designed for 3,000 volts and a frequency of 15. The normal output of each motor is 390 h.p. when the speed of the locomotive is 34 km./hour, and 450 h.p. when the speed is 68 km./hour; the maximum continuous output is 575 h.p. The change of speed from the lower to the higher value is effected by changing the stator poles from 16 to 8. The rotor is provided with a 6-phase winding, so that no change of connections is necessary when the number of stator poles is altered. The starting resistance in the rotor circuits is connected to a controller having 18 running notches. The author constructs the Heyland circle diagrams for the two groupings of the stator circuits, and calculates the saving of energy—which amounts to 22·5 per cent.—during the acceleration period due to the use of the larger number of poles. A. H.

1812. *Electrical Plant of a Modern Ocean-going Passenger and Cargo Vessel.* C. J. Dougherty. (Eng. Club Phil., Proc. 24. pp. 284–305; Discussion, pp. 305–306, July, 1907.)—The electrical generating plant of the *Momus*, a vessel of 10,600 tons displacement, trading for the South Pacific Railway along the Atlantic coast, consists of two compound-wound, 75-kw., 110-volt, 2,400-r.p.m. turbo dynamos, and of one 10-kw. reciprocating set, all mounted on a platform in the engine-room. With 250 lbs. steam pressure the turbo sets took on test only 24·5 lbs. per kw.-hour. The switchboard contains 8 panels with 14 feeder switches; the two larger machines are arranged for operating in parallel, but the smaller one is connected to an independent set of bus-bars for the day load, the switches at the board being of the change-

over type. There are five feeders for lighting, the remainder being for ventilation, heating, cargo, and searchlight. Enamelled and galvanised conduit is used in the wiring of the engine- and boiler-rooms, cargo holds, and exposed places. The port, starboard, masthead, and range lights are wired in duplicate, and connected through small change-over switches to a tell-tale board containing indicating lamps and bells. In the cabins and corridors 120 electric heaters of 750 watts, and 40 of 1,800 watts capacity, are installed; they are wound with German-silver ribbon in two sections, which can be switched in either separately or together, so giving "low," "medium," or "high" degrees of heat. An electric whistle operator is fitted by which the whistle can be automatically blown for 6 sec. during every minute. A de Forest wireless telegraph outfit has been installed. The total weight of the electrical plant, communications, &c., is 48½ tons. In the *discussion*, **C. Hering** pointed out that electric heaters were advantageous if for intermittent use only, steam being best for ships in which heating is required for long periods; also that electric heaters should be rather large and run at a fairly low temperature. H. F. H.

1313. *Single-phase Traction on Erie Railroad.* **W. N. Smith.** (Eng. Record, 56. pp. 399–405, Oct. 12, 1907. Electrical World, 50. pp. 719–724, Oct. 12, 1907. Elect. Engineering, 2. pp. 714–717, Nov. 7, 1907.)—The section of track equipped is 34 miles long, and extends 19 miles over the main line of the Rochester division from Rochester to Avon, and thence 15 miles over the Mt. Morris branch. The power is generated at Niagara Falls, and is transmitted at 60,000 volts (3-phase) to the substation at the Y formed by the railway tracks at Avon. Each of the 60,000-volt lightning arresters consists of three horn gaps arranged in series with each other, the gaps being 4¾, 5, and 6 in. long respectively. Between the first and second gaps is interposed a concrete column, between the second and third an electrolytic arrester, and between the third and earth a 5-ft. fuse of No. 18 copper wire. Both horns of each gap are of ½ in. round iron. Between the line and the first gap is placed a hook-type knife switch. The 60,000-volt conductors enter the building through glass discs set in the wall; they then pass through three stick-type circuit-breakers to oil-insulated choking coils, instrument series transformers, and terminate upon a set of copper bus-bars arranged at a convenient height directly over the three main transformers, which are of the Westinghouse oil-insulated water-cooled type. Each transformer has an output of 750 kw., and the secondary windings are at present arranged to give 11,000 volts (but may, should occasion require, be connected up to give 22,000 volts in the future). Besides acting as step-down transformers, they effect a phase transformation from three to two phases. The overhead line, which is supplied directly at 11,000 volts, is divided into two sections, each fed by one of the phases. The trolley wire is of No. 000 B. & S. grooved copper, supported every 10 ft. by hangers suspended from a seven-strand steel messenger cable $\frac{7}{16}$ in. diam. The insulators are 6⅞ in. diam. and 6 in. high, with malleable iron pins; the tie wires are of No. 9 galvanised telegraph wire. Each bracket is 10 ft. long, and consists of a 3 × 2½ in. tee, the heel of which is fixed to the pole by a pair of bent straps, while the outer end, not far from the insulator, is supported from the top of the pole by two ⅝-in. tie-rods. The poles are of chestnut, averaging 35 to 40 ft. in height, and in circumference 25 in. at top and 42 in. at base. The trolley line is divided into 7 sections by trolley section insulators of the overlapping type, made of impregnated wood; normally, the sections are all connected to each other, as the only feeders are

those connecting the end of the line to the substation; the section insulators are only provided to facilitate fault localisation. The electrical equipment of the cars consists of four No. 132A Westinghouse single-phase railway motors, with a nominal rating of 100 h.p. each. The control is of the Westinghouse electro-pneumatic type. Pantagraph bow type trolleys are used. This line has been in successful operation since June 18. A. H.

1314. *2,000-volt Continuous-current Railway.* (Elect. Engineering, 2. pp. 639–647, Oct. 24, 1907.)—The railway described, which connects the Moselhütte blast furnaces in Lorraine with their iron mines at Ste. Marie, is 8·7 miles long, and at present carries about 2,600 tons of ore per day. Power is supplied to the line from two substations, one at each end of the line. Each substation contains a 5,700-volt synchronous 3-phase motor giving 880 h.p. at 375 r.p.m., its starting motor, a 600-kw., 2,000-volt continuous-current generator, and a 65-volt exciter which supplies current to the fields of both the synchronous motor and the generator. The armatures of all four machines are mounted on a common shaft carried in two bearings. The starting induction motor is supplied at 500 volts. The generator is fitted with commutating poles, and around the commutator are placed radial partitions of insulating material which separate brush sets of opposite polarity and are intended to prevent flashing over. The brush-holders are insulated from the rocker, which in its turn is insulated from the frame of the machine. The overhead line consists of two trolley wires, each 55 sq. mm. in cross-section, supported by double hangers in such a way that both wires are certain to be in contact with the bow trolley; the wires are 180 mm. apart. The maximum voltage drop along the overhead line and rail return is 15·5 per cent. The locomotive is supported on two four-axled bogies, each axle being driven through single-reduction gearing by a 160-h.p. 4-pole motor. The motors are permanently connected in two groups of two in series. The motor armatures have 61 slots, and the commutators 83 segments. Commutating poles are provided. A hand-operated controller is placed in the driver's cab. The main cut-out has an air-break, as it has been found that a break under oil gives rise to violent surgings in the case of continuous currents. A. H.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

1315. *Combined Single-phase and Continuous-current Traction.* (Elect. Engin. 40. pp. 543–544, Oct. 18, 1907.)—The A.E.G. of Berlin has patented an arrangement of overhead conductor and switchgear by means of which the change from high-voltage single-phase to continuous-current supply is effected automatically. Between the single-phase and continuous-current sections of the overhead conductor are inserted insulated dead sections: over these the car is made to coast. As soon as it reaches a live section, the appropriate automatic switches come into play and close the required circuits. A. H.

1316. *Single-phase* v. *Direct-current Railway Operation.* **M. MacLaren.** (Elect. Journ. 4. pp. 461–468, Aug., 1907.)—This article is a criticism of that portion of Parshall and Hobart's book, *Electric Railway Engineering*, which deals with single-phase equipments. Figures of the weights of equipments

[1] Non-electrical Automobiles are described in the Section dealing with Steam and Gas Engines.

on the Indianapolis and Cincinnatti Traction Co.'s single-phase cars are quoted, and the following comparison is given: That whereas the present car with single-phase equipment weighs 48 tons complete, the same car equipped for continuous-current operation would weigh 43 tons (this allowing for the lighter trucks and framework possible with the lighter direct-current equipment). Thus the single-phase car is only about 12 per cent. heavier than that for continuous-current operation, although the electrical equipment is about 40 per cent. heavier. The figures given in the above work, for the impedance per mile of circuit consisting of overhead wire and rail return are stated to be higher than the figures obtained by measurement in America. The example worked out is also criticised. [The decimal point has—due to a printer's error—been omitted in the two figures given in the example in the book referred to; instead of 18 per cent. and 80 per cent. they should read 1·8 per cent. and 8·0 per cent. The table in Parshall and Hobart's book is correct, and it is only in the example chosen by the author (which followed the table), that the printer's error occurs]. In answer to the statement made in the above-mentioned work, that the rating on the 1-hour 75° C. basis is too favourable to the single-phase motor, the author gives the following results of actual test :—

	1-hour rating 75° C.	Continuous rating 75° C.	Continuous rating as percentage of the 1-hour rating.
Continuous current	90	80	44 per cent.
Alternating current, 25 ∿ ...	100	51	51 „

The author then criticises the comparison made between a single-phase and a continuous-current installation for a 60-mile road (the original comparison was made by Lincoln in his paper "Interurban Electric Traction Systems," in 1903, and was revised by Hobart in the *Electrical Review* for April 29 and May 6, 1904, pp. 698 and 765). The author complains that the comparison is made between the costs of the electrical equipment only, and that consequently the extra cost of the steam engines, boilers and equipment in the case of the two power stations required for the continuous-current operation is not considered. With the above and with other lesser modifications the comparison is again made, and the author arrives at a capital cost for the single-phase system amounting to some 90 per cent. of that for the continuous-current system. The operating expenses are given in detail and are also favourable to the single-phase system. H. M. H.

1317. *Single-phase Traction.* **A. Heyland.** (Elektrotechn. Zeitschr. 28. pp. 893–896, Sept. 12, and 922–926, Sept. 19, 1907. Paper read before the Verband Deutscher Elektrotechniker.)—The author first briefly reviews the developments of single-phase traction which have been rendered possible by the introduction of commutator motors. The design of such motors may now be regarded as having reached finality, and it would be idle to expect further improvements. A good deal of controversy has taken place regarding the relative merits of the two rival types of motor now in use—the series and the compensated repulsion motor—but a careful analysis of the characteristics of these two types shows that they are about equally good, although in special cases one or other may be preferable. The size and cost of such motors are about 150 per cent. of those of continuous-current motors of equal output; the commutator of a series motor is somewhat larger than that of a compensated repulsion motor. The transformer must in each case be capable of dealing with the total output of the motors, but may be some-

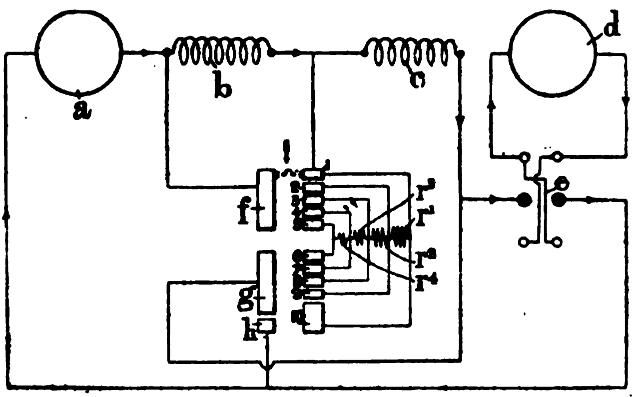
what smaller for the second type than for the first (series). The switching arrangements are simpler though heavier than for continuous-current motors. The power-factor is in both types of motor high under normal running conditions, but low at starting. The great weakness of commutator motors is the sparking difficulty *when starting*. If single-phase traction is to make further progress, commutators must be abolished, and the power-factor at starting improved. One method of doing this devised by the author is described in Abstract No. 1291 (1907). The following is, however, regarded by the author as affording the best solution of the problem. The stator of one of the main motors is provided with a winding consisting of single coils (instead of a distributed winding), which may therefore be wound for a very high voltage, and is in direct connection with the supply mains. The rotor of this motor has a polyphase winding connected, through slip-rings, to an auxiliary polyphase commutator motor whose rotor is also provided with slip-rings. Lastly, these slip-rings are connected to the stator of the second main motor, which has a simple short-circuited rotor. When the main motors are at rest, the auxiliary motor is running at synchronous speed. By suitably displacing its brushes, the speed may be increased, and the main motors start with a very powerful torque, while at the same time the power-factor is very high. As the speed of the main motors increases, the frequency and voltage of the currents supplied to the auxiliary motor automatically decrease, with the result that its speed remains nearly constant at all loads, so that when the main motors are running the auxiliary motor runs at a speed above synchronism. Although this method requires the use of a commutator in the auxiliary motor, it will be noticed that at starting, when the heaviest current is drawn from the mains, the commutator motor is running at synchronous speed—*i.e.*, under the most favourable conditions for commutation; while at other times, although the speed is above synchronism, both the frequency and the voltage have decreased to a fraction of their values at starting, and commutation is again satisfactory. The following advantages are claimed for this system over that employing commutator motors: Absence of commutation troubles, high power-factor at starting and when running, entire absence of all series resistances and consequent high efficiency during acceleration period; smaller total weight and price of electrical equipment, and smaller space occupied by motors; and entire absence of transformers and complicated switching arrangements.

A. H.

1318. *Contact Resistance in connection with Rail Bonding.* (Street Rly. Journ. 30. pp. 389–391, Sept. 14, 1907.)—A description of some tests made, under the direction of Richey, at the Worcester Polytechnic, to determine the relation between pressure, contact area, &c., and the contact resistance of rail bonds. Discs of copper 0·25 in. thick and of various diameters were compressed between two steel cylinders and the contact resistance measured by the drop of potential method, using small currents. Pressures up to 60,000 lbs. per sq. in. were employed. The contact resistance was found to vary in a definite ratio with the area of contact (for a given pressure per sq. in.). The minimum contact resistance is practically reached at a pressure of 25,000 to 30,000 lbs. per sq. in. It is inadvisable to exceed this pressure very much, because the elastic limit of the steel would then be exceeded. To obtain this pressure at the contact surface, a pressure 6,000 to 10,000 lbs. higher (per sq. in.) must be applied to the ends of the bond terminal. There is no advantage in increasing the area of the bond terminal unless the

pressure applied (in lbs.) is correspondingly increased. The contact resistance between annealed cast copper and steel was found to be considerably higher than that between annealed rolled copper and steel. A soda-water or soap-sud film causes only a very slight difference in the contact resistance, but an oil film causes a considerable difference; nevertheless it is thought advisable to use oil as a lubricant when drilling the rail, as the presence of moisture at the joint may cause corrosion. H. M. H.

1319. *Electromagnetic Speed Control for Motor Vehicles.* (Elect. Engin. 40. pp. 520–521, Oct. 11, 1907.)—In a provisional specification [No. 12,840 of 1906], A. P. Zani describes the following method of controlling the fields of the generator and motor used in the arrangement recently invented by him [Abstract No. 794 (1907)] for electromagnetically varying the speed of the driven shaft. A set of resistances, marked r_1, r_2, r_3, and r_4 in the Fig.,



is provided, by means of which, so long as the bridging contact brush moves along *f*, the field *b* of the generator is shunted, the motor field *c* receiving the full current from the generator. On moving the contact brush down *g*, the field *c* of the motor is shunted more and more heavily, until finally, when the contact brush reaches *h*, *c* and *d* are thrown out of action, the shaft being now driven by the torque exerted on *b* by the armature *a* which is coupled to the prime mover. This method of working does not require any battery or auxiliary generator for supplying current to the field windings *b* and *c*. A. H.

1320. *Economic Renewal and Maintenance of Railway Tracks for High-speed Traffic.* L. Schlüssel. (Engineer, 104. pp. 197–198, Aug. 23, 1907. From Bulletin of the Internat. Rly. Congress Assoc., April, 1907.)—The author's contention is that, in spite of the various improvements which have been made in the construction of permanent way, a great deal remains to be done. He deals only with spiked roads in alluding to the part played by the track; and observes that the latter should act as a long spring capable of taking up equally and at every point over its length the forces which will result from moving loads. If the running is to be smooth the forces must be taken up progressively and without impact, and the absorption must be effected by the diminishing elasticity of the constituent parts of the track. Some consider the dynamic forces should be absorbed chiefly in the super-

structure, and others that it should take place on the foundation. The author considers that it is the system giving the greatest stiffness which should be preferred. He gives preference to the type with short, stiff sleepers, heavy rails and supported joints, accompanied by fastenings which cannot be worked loose, and cohesion of sleepers and ballast so as to obtain the maximum amount of stiffness. Greater stress is laid upon the necessity of maintaining a close and constant contact between the flange of the rail and the sleeper; in order to ensure this adhesion two new developments have been introduced consisting of: (1) Using as fastenings wedges and cramps to ensure adhesion between flange and sleeper; (2) the use of shock-absorber or deadener blocks vertically below the rails, reducing the amplitude of their elastic movements. Concerning creeping, he says that the longitudinal forces acting on tracks are very great, but hitherto the determining of their amount has been very uncertain. One of the more important causes is the impact of the wheel when passing from the trailing end to the facing rail end, the elastic non-supported joints with fishplates, having little strength transversely, transmitting part of the transverse forces acting on the trailing rail-end to the facing rail-end. The supported joint and the greater transverse strength would reduce creeping by giving the track more continuity. It has been observed that the friction between the sleeper and the ballast has by itself not sufficed to prevent creeping. As to the distribution of vertical forces, the author would increase, first, the supporting surface immediately below the rail, and secondly the stiffness of the sleeper. Metallic sleepers are chosen because they have longer life and require less maintenance. The form of the sleeper is a large channel section with the parts most subjected to stress reinforced, under which rail a block of wood supports the non-reinforced part of the top of the sleeper and acts as a deadener. Full details are given of the system. C. E. A.

1321. *Third-rail Design.* **E. Goolding.** (Tram. Rly. World, 22. pp. 211–212, Sept. 5, 1907.)—The author, in commencing his paper, proceeds to point out that no particular design of steel conductor rail has yet been standardised. Maintenance expenses cannot be dealt with satisfactorily, railway statistics not offering a means of comparison, therefore the writer has confined his attention to the various practical advantages claimed for the respective systems now in operation (illustrations of six types given); and for the purpose of comparison four main points are to be borne in mind. (1) The width of rail to be as narrow as practicable, and thereby minimise the space occupied on the track, so as to clear ironwork on bridges, &c. (2) Distance between rail and earth to be as great as possible to obtain good insulation. (3) Section must be such as to admit good mechanical attachment for wood protection, and to enable easy punching of holes for fishplates, bonding, and anchoring. (4) The rail to have a good base for seating on insulations, and also to have a crown to give a good contact area for the collector shoe. After comparing the six types, the methods adopted for supporting and attaching the wood guard are next touched upon. Protection boards should be sufficiently close together to enable the foot to span the same, and they should be detachable and interchangeable. C. E. A.

1322. *Standardisation of Rail Sections of the German Street and Interurban Railway Association.* (Street Rly. Journ. 30. pp. 394–396, Sept. 14, 1907.)—Previous reports have covered the subjects of rail specifications and rolling stock [see Abstracts Nos. 444 and 1202 (1907)]. The present report deals

with rail sections. Fifteen sections are proposed for standardisation, these consisting of five each for grooved, composite, and T-rails respectively and for wheel pressures from 2 to 6 tons. The dimensions and weights of the standard rail sections recommended are deduced from values of the average pressure on street railway foundations with rigid track. Compound rails are similarly treated. In studying the carrying power and stability of compound rails, it is unnecessary to consider the guard rail, since the running rail can be used without it. The report contains complete data of the standard grooved rails, compound rails, and T-rails. A. G. E.

1323. *Standardisation of Street Railways Details.* (Street Rly. Journ. 30. pp. 424–432, Sept. 21, 1907. Account of Meeting of Committee on Standards of the Amer. Street and Interurban Rly. Engin. Assoc., Sept. 12, 13, and 14, 1907.)—Continuation of the discussions referred to in Abstract No. 1205 (1907). The sub-committee's proposed standard axles are practically as before proposed; a few further details and drawings are now added. From opinions gleaned by **V. Angerer** from a number of firms, and also expressed by several speakers, it appeared to be impossible to adopt a universal standard 3¼-in. wheel-tread with ⅞-in. flange height, as the rails in some towns, as well as at special crossings, &c., are unsuitable. Angerer also gives a drawing in which a number of existing rail sections are superposed. Proposed standard designs for brake-shoes are submitted. For 3-in. tread and upwards, the width of flat portion of shoe, whether flanged or not, is 3 in.; for the smaller treads it is 2¼ in. There appeared to be no unanimity on such points as permissible limits in gauge between wheels and the exact point where the measurement should be made, and taper of wheels. F. R.

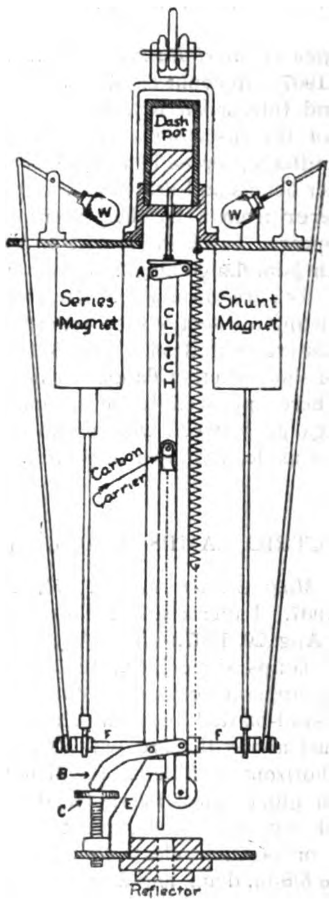
ELECTRIC LAMPS AND LIGHTING.

1324. *Operation of Magnetite Arc Lamps.* **H. Grabill.** (West. Electn. 41. p. 181, Sept. 7, 1907. Paper read at Toledo Convention of the Ohio Electric Light Assoc., Aug. 20, 1907.)—The Ashland Gas and Electric Light Co., have used these lamps since Dec., 1905, and recommend the form (type 3) in which the upper electrode is stationary, with a globe having a closed frosted or sand-blasted bottom. An enamelled iron reflector is placed horizontally just above the arc, with the result that the maximum distribution is almost horizontal. The lamp will not burn unprotected from the air, so the broken globes must be replaced at once. In lamps taking 320 watts at 70 to 80 volts on direct-current series circuits, the reversible heavy copper upper, or positive, electrode lasts 4,000 hours. The lower electrode, an iron tube 5/8-in. diam. and 8 in. long filled with black magnetic oxide of iron lasts 175 hours. Lamps need only be trimmed nine times a year. Some information is given as to the adjustment of the lamp which, however, assumes knowledge of its construction. Repairs and renewals cost 2s. 7d. per lamp. The Company referred to regard the lamp as the best at present in operation. See Abstract No. 1458 (1906) for some further figures as to the cost of working these lamps. C. K. F.

1325. *The "Helion" Filament Lamp.* **W. G. Clark.** (Elect. Rev., N.Y. 51. pp. 411–412, Sept. 14, 1907. Elect. Rev. 61. pp. 603–604, Oct. 11, 1907. Abstract.)—The "Helion" filament is built upon a carbon base by deposition of a compound containing silicon in an ordinary flashing

apparatus [see Abstract No. 214 (1907)]. The emissivity increases and the light becomes whiter in colour. It is said to be possible to reach a temperature of 3,300° C. without any sagging or softening of the filament. At 1,700° it takes about 1 watt per c.p. W. H. S.

1326. *The "Flamor" Flame Arc Lamp.* (Elect. Rev., N.Y. 51. p. 381, Sept. 7, 1907.)—In this lamp, when the current is turned on, the carbon-carrier is gripped by the clutch and lifted by the series magnet and counter-



weights W, W, so as to move the inclined carbons apart. Feeding of the carbons takes place when the extended link B bears on the table C. No details are given of the construction beyond those appearing in the diagram. C. K. F.

1327. *The Heraeus Mercury Lamp.* O. Bussmann. (Elektrotechn. Zeitschr. 28. pp. 932–934; Discussion, pp. 934–936, Sept. 19, 1907. Paper read before the Elektrotechn. Verein, May 28, 1907. Elect. Engineering, 2. pp. 549–550, Oct. 10, 1907.)—When working in the laboratory of Heraeus at Hanau, R. Küch discovered the art of mounting a mercury

vapour lamp in a bulb of quartz. Owing to the high melting-point of quartz, it was found possible to run the lamp at less than 0·2 watt per c.p. Mercury lamps, made of glass, taking 110 volts, are 110 cm. long, and 3 or 4 cm. in diam.; if made of quartz, the length is less than 8 cm., and the diam. about 1 or 1·5 cm. The quartz lamps can therefore be mounted in fittings exactly similar to those used for arc lamps. When the light is first switched on, it fills the whole of the tube, but gradually contracts to a bright thread, with a very notable improvement in the colour of the light, which can easily be noticed without any spectroscopic devices by merely holding a sheet of red glass in front of the lamp. The ordinary mercury lamp works under a vacuum; but in the quartz type the temperature is sufficient to create a pressure equal to that of the atmosphere, and it could be raised still higher if there were no possibility of accident. Tests at the Reichsanstalt have shown that with 174 volts and 4·2 amps., the horizontal c.p. in Hefner units is 3,080, the consumption being at the rate of 0·24 watt per c.p., but this does not take into account the loss in the series resistance. The actual temperature at 60 volts has been found to be 1,700° C. by means of thermopiles, and as it appears to follow a straight-line law, it would seem to be in the neighbourhood of 6,000° C. at 180 volts. For experimental purposes the voltage has been raised to 250, and this corresponds to an internal pressure of 2 atmos. The poles are surrounded by a form of metallic radiator in order to reduce the temperature at these points. Lamps taking 3 or 4 amps. at 220 volts are to be sold for £10; the price largely depends on the cost of transparent quartz, seeing that a lamp requires about 80 gm. which costs £4. The *discussion* was mainly concerned with the possibility of photometrically comparing lights of different colours. **Gehrcke** stated that it had been found that the addition of some zinc to the mercury improved the colour of the light. **Heraeus** stated that amalgam lamps of various kinds had been thoroughly tested in his laboratory; but it was found that no improvement was noticeable after the lamp had been burning for a short time. This may be due to the fact that the added element is soon transferred to the one pole, and leaves the spectrum the same as before the addition of the foreign metal was made. He also said that attempts to use the mercury lamp as a heater for filaments of the Nernst type had proved failures. W. H. S.

1328. *Glazed Searchlight Reflectors.* **U. Cisotti.** (N. Cimento, 13. pp. 375–389, May, 1907.)—Determines the best form of a metallic reflector covered with glass. Rejects Mangin's spherical surface as requiring a glass covering of varying thickness. Decides upon an approximately parabolic surface with glass of uniform thickness. The equation to the generating curve of both surfaces is—

$$y^2 = px + 4hx\sqrt{\frac{4x+p}{4(n^2-1)x+pn^2}},$$

where p is the *latus rectum* of the original parabola (without glass), h the thickness of the glass, n its refractive index, and d the diam. of the reflector. If $p = 168$ cm., $h = 1$ cm., $n = 1{\cdot}54$, and $d = 90$ cm., and a luminous point is placed at a distance $p/4 = 42$ cm. from the vertex, the angle of the emergent cone will not exceed 1° 30′, and at a distance of 10 km. the rays will be spread over an area not exceeding 500 m. in diam. E. E. F.

1329. *The Nernst Lamp.* **O. Foell.** (Elect. Rev., N.Y. 51. pp. 428–432, Sept. 14, 1907.)—This paper gives some general information about the Nernst

lamp. The following are some of the more important details. The average performance of a standard Nernst glower at constant wattage is as follows:—

Life.	Voltage.	Per Cent. Increase.	Candle-power.	Per Cent. Depreciation.
0	202·0	0·00	44·5	0·0
25	200·0	−1·00	44·3	0·5
100	197·2	−2·38	44·0	1·1
200	199·0	−1·49	43·6	2·2
300	200·8	−0·60	42·5	4·5
400	202·6	0·30	41·4	7·0
500	204·3	1·14	40·0	10·0
600	206·3	2·13	38·9	12·6
700	208·0	2·97	37·6	15·5
800	210·0	3·96	36·5	18·0

One type of glower terminal in use comprises a ribbon of platinum pressed around the glower string and fused together at the ends, the terminal being coated with ground glower material; the terminal applied to the standard alternating-current glower of American make (the Hanks terminal) consists of a bead of platinum fused into the end of the glower material. The curve of current and voltage of a 0·4-amp. glower is also given. Large glower strings are made tubular. Direct-current glowers are made as porous as possible to permit the escape of the anodic oxygen liberated by reason of the electrolytic effect of the current in the glower string. For this reason the positive terminal is a Hanks terminal and the negative a band terminal. A large amount of heat is liberated at the positive terminal by reason of the Peltier-effect, its radiation being facilitated by the construction of the Hanks terminal; heat is for the same reason absorbed at the negative terminal. The glass container of the ballast resistance is surrounded, in the case of high-efficiency lamps, by a metallic cooler, *e.g.*, a copper spring, which reduces the effect of ballast sluggishness. The paper includes views and description of some new types of high-efficiency lamp and the results of some tests. A system of series working is also described, in which each lamp has a transformer operated from a constant-current line. This transformer has an air-gap in its magnetic circuit, so as to permit a large primary magnetising current without heating of the iron on open secondary. It also tends to flatten the current-voltage characteristic on the secondary side. With this system the glowers can be operated without a ballast.

C. K. F.

1330. *Economy of the Tungsten Lamp.* A. A. **Wohlauer.** (Electrical World, 50. pp. 453–456, Sept. 7, 1907. Écl. Électr. 53. pp. 69–72, Oct. 12, 1907.)—This paper contains a study of the question as to what extent the tungsten lamp is likely to effect a saving from the monetary point of view. The lamp seems likely to be sold for 6s., and will have a life of 1,000 hours with an efficiency of 1 watt per c.p. Tables are given showing the total cost of the production of light, including the cost of energy and the prime cost of the tungsten lamps of different c.p., various rates of charging being allowed for. The first table gives the cost per lamp-hour, and the second gives it per candle-hour. When compared with carbon lamps at 8d. each with lives of 450 hours, the candle-hour of the tungsten

lamp is cheaper than that of the carbon lamp for rates ranging down to 2d. per kw.-hour, If energy were charged at the rate of 5d. per kw.-hour, the saving would amount to 40 per cent. If the price of the tungsten lamp were to be reduced to 8s., its use would result in an economy even in those cases where the rate for energy was less than 2d. per unit. W. H. S.

1331. *Production of Metallic Filaments.* (Elect. Engineering, 2. pp. 414–415, Sept. 12, 1907.)—The British Thomson-Houston Co. (from *Gen. Elect. Co., U.S.A.*) have patented a process whereby refractory material, even though non-ductile, may be shaped into wires or other forms and then consolidated into coherent conductors suitable for use as filaments in glow-lamps. (Brit. Pat. 18,749 of 1906.) The process is stated to be applicable to the metals W, Mo, B, Zr, Ti, or compounds or alloys of these metals. The refractory substance is impregnated, when hot, *in vacuo*, with a ductile metal or alloy of lower melting-point, the product so obtained being then sintered together and consolidated by passing current through it after the desired form has been given to the material, when the ductile or low melting metal is driven off by reheating. The ductile metals specified as suitable are: Cu, Cd, Au, Ag, Hg, Bi, Sn, or certain amalgams. The process as applied to the production of tungsten filaments is explained more in detail, for which see original. It is stated that tungsten impregnated with Ag or Cd is white, whilst tungsten or the other refractory metals become yellow or salmon-coloured when impregnated with copper. (Ibid. p. 456, Sept. 19.) Brief abstracts of two further patents of the British Thomson-Houston Co. (*General Electric Co., U.S.A.*). These both concern the production of tungsten filaments: the first by the use of colloidal silver, and squirting; the second employs tungsten wire made by the ordinary process, which is then flattened into strip by rolling, and passed through a die so as to curl the strip into tubes. These are finally heated *in vacuo* to remove the Cd and Hg of the binding material and to sinter the particles of tungsten (Brit. Pats. 18,488, 18,748 of 1906). L. H. W.

1332. *Boron Lamp-filaments.* (Elect. Engineering, 2. p. 415, Sept. 12, 1907.)—The British Thomson-Houston Co. (communicated by Gen. Elect. Co., U.S.A.) heat a boron nitride to a temperature sufficient to decompose it and yield pure boron (Brit. Pat. 25,978 of 1906). The nitride is obtained by passing ammonia over boric anhydride or boric salts. The finely-divided nitride so obtained is white, non-conductive, and capable of compression into sticks. This nitride is heated above 1,500° C. in a vacuum, the nitrogen being removed as fast as it is produced. The best temperature is 2,000° C., maintained for several hours, and a boron or boron nitride crucible is preferably used. The physical properties of the boron produced in this way differ from those usually ascribed to boron: it is conductive and melts at very high temperatures without volatilisation. To use it for lamp-filaments, it is mixed with a small quantity of vapourisable binder which will leave practically no carbon behind, such as paraffin. L. H. W.

REFERENCES.

1333. *Calculation of Most Economical Size of Conductor.* R. Goetzke. (Ecl. Electr. 52. pp. 449–451, Sept. 28, 1907.)—Formulæ and tables are given by the author intended to facilitate the calculation of the most economical size of a feeder. A. H.

1334. *Development of the Chicago Edison and Commonwealth Electrical Systems.* **E. F. Smith.** (West. Soc. Engin., Journ. 12. pp. 409–482; Discussion, pp. 482–487, June, 1907.)—In the descriptive portion the vertical 2,000-kw. frequency changers for changing the 25-$\sim$, 9,000-volt 3-phase current into 60-$\sim$, 4,150–2,400 volt, 4-wire, 3-phase currents are described. [See also Abstracts Nos. 146 (1904) and 714 (1907).]

1335. *Electric Reversing Rolling-mill at the Hildegarde Ironworks.* **D. S. Bigge.** (Iron and Steel Inst., Journ. 73. pp. 57–87; Discussion and Correspondence, pp. 88–103, 1907. Abstracts in Elect. Engineering, 1. pp. 913–918; Discussion, pp. 918–919, May 30, 1907. Electrician, 59. pp. 512–514, July 12, 1907.)—Abstract No. 415 (1907) completely covers the ground of this paper. The *discussion* raises several important points, while in the *correspondence* **R. Herzfeld** gives estimates of capital outlay and working cost for a steam turbine and a gas-engine installation.
L. H. W.

1336. *The Friedrich-Alfred Ironworks at Rheinhausen.* (Stahl u. Eisen, 27. pp. 1445–1484, Oct. 9, 1907.)—A very full account of the equipment. The electrical plant comprises six large generators driven by six gas engines of 1,000-b.h.p. each, electrical power being used in many departments. L. H. W.

1337. *Catenary Line Construction on the New York, Haven, and Hartford Railroad.* (Electrical World, 50. pp. 323–327, Aug. 17, 1907. Street Rly. Journ. 30. pp. 245–254, Aug. 17, 1907.)—[See Abstract No. 691 (1907), and for power plant, locomotives, &c., Nos. 1187, 1199 (1907).]

1338. *Calculation of Acceleration Curves.* **W. Kummer.** (Elektrische Kraftbetr. u. Bahnen, 5. pp. 523–528, Sept. 24, 1907.)—The author shows how, given the resistance to the motion and the mechanical characteristic of the motor, to determine the curves connecting velocity and acceleration with time. A. H.

1339. *Train Resistance.* (Engineering, 84. pp. 114–115, July 26, 1907.)—A review of published experimental results.

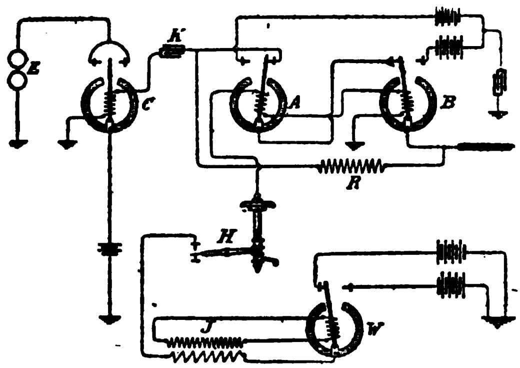
1340. *Developments in Glow-lamps.* **L. Gaster.** (Elect. Engin. 40. pp. 230–283; Discussion, p. 283, Aug. 16, 1907. Paper read before the British Assoc. at Leicester. Electrician, 59. pp. 764–765, Aug. 23, 1907. Abstract.)—Reviews recent developments, dealing more fully with the tungsten lamp, the zircom-wolfram lamp, and the "helion" lamp. Reference is made to Hammer's views as to the lines along which further research might be advantageous. [See Abstract No. 443 (1907).] L. H. W.

1341. *Flame Arc Lamps.* (Elect. Engineering, 1. pp. 95–99, Jan. 17, and pp. 165–168, Jan. 24, 1907.)—Traces the evolution of the flame arc lamp and gives diagrams and descriptions illustrative of the modes of operation and regulation employed in the "Excello," Angold, Oliver, "Juno," Santoni, and Gilbert lamps. L. H. W.

1342. *Train-lighting.* (Elektrotechn. Zeitschr. 28. pp. 435–438, April 25, 1907.)—The system described is one utilising Rosenberg's constant-current dynamo [Abstract No. 898 (1905)] in conjunction with a battery of secondary cells. The dynamo is a 6-kw. one, and supplies the entire train; it is arranged underneath the luggage van, and is driven by belt from a pulley on one of the axles. The system is in regular use on a number of Continental trains, and has proved very satisfactory. An aluminium cell prevents a reverse current from the battery when the train is not in motion [see Abstract No. 721 (1907)]. A. H.

TELEGRAPHY AND TELEPHONY.

1343. *New Arrangements of the Hughes Apparatus in Long Overhead Circuits and in Cables.* (Archiv Post Tele. 8. pp. 233–238, April, 1907. Elektrotechn. Zeitschr. 28. pp. 1043–1044, Oct. 24, 1907.)—This is an account of the improvements introduced by Picard in France and by Battaglia-Guerrieri in Italy. [Abstract No. 1358 (1907).] Picard has applied to the problem of transmission by the Hughes the principle of an electrically



symmetrical state of the line or cable. It is arranged that an emission of + sign shall find the circuit charged —, and an emission of — sign shall find it with a + and equal charge. The neutral state is avoided. The Fig. shows the arrangements adapted to attain this end. A and B are intermediate relays, and C is the receiving one. E. O. W.

1344. *Method of producing Undamped Oscillations by means of Alternating Currents.* (Brit. Pat. 7,942 of 1906. Engineer, 103. pp. 589–590, June 7, 1907. Abstract.)—The object of S. Eisenstein's invention is to produce interrupted short trains of undamped or slightly damped oscillations using an alternating or an interrupted direct current as source. This is said to be achieved by producing an overlapping of the oscillations and a building up of the potential, illustrated by curves in the patent specification. The source of energy is only connected to the oscillatory circuit for a brief interval at each half-period of the low-frequency current, during which interval the total energy of the whole half-period acts in the oscillatory circuit. The simplest arrangement shown comprises a condenser in the transformer secondary, of such dimensions that its discharge occurs at every half-period. This discharge takes place through a spark-gap, a mercury vapour gap, and the primary of the transmitting jigger, the latter two parts being shunted by a condenser. L. H. W.

1345. *Resonating Transformers with Divided Magnetic Circuits in Wireless Telegraphy.* Gaiffe and Gunther. (Comptes Rendus, 145. pp. 566–567, Sept. 30, 1907.)—The authors describe the advantages of a resonating transformer in which the primary and secondary are apparently on separate cores with gaps between. These advantages are (1) that since the secondary

is connected to capacities, the secondary flux is in phase with the primary; (2) that the secondary flux is only limited by the joulean waste, hysteresis, and eddy currents, and may therefore be much greater than the primary flux; (3) a very much higher voltage may be obtained than that in an ordinary transformer where the oscillations are forced; (4) the increased secondary flux cannot interfere with the primary which forms a species of magnetic screen to it; (5) hence it is possible to give the primary core a much smaller section than that of the secondary, since the flux is so much less; (6) from the above it is evident that the surgings caused by sparks in the secondary circuit, or by an accidental short-circuit, do not react on the primary or on the source of supply. J. E.-M.

1346. *New Arrangement for producing Continuous Oscillations from High-voltage Direct Current.* **A. Blondel.** (Rev. Électrique, 8. pp. 75–77, Aug. 15, 1907. Paper read before the Assoc. franç. pour l'avancement des Sciences, at Rheims. Écl. Électr. 52. pp. 480–482, Sept. 21, 1907. Electrician, 60. p. 216, Nov. 22, 1907.)—The author describes a new arrangement of circuits by which a high voltage can be used as source in generating continuous oscillations. The arc is not employed; the chief feature is the use of a regulating condenser K, of large capacity, and associated with a second condenser *c* of less than one-fifth the capacity of the large one (see Fig. 1).

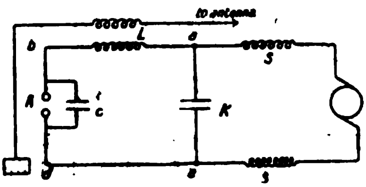


FIG. 1.

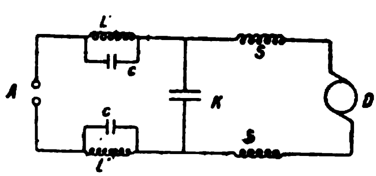


FIG. 2.

The condenser K is charged direct by the dynamo, there being one or two impedance coils (S, S) interposed. The small condenser *c* shunts the spark-gap, and discharges itself through the gap as soon as the sparking voltage is reached. Whereupon the condenser *c* recharges itself by the aid of the self-inductance L. The rapidity of this discharge depends upon the natural period of the circuit AbCdKa and is determined by the e.m.f. available at the terminals of the condenser K; the natural period is the longer, the larger the capacity K. If large self-inductances are used for the impedances SS, the period can be prolonged; and by adding resistances the oscillations can be damped. The device is self-regulating. To get rid of all tendency for the discharge to persist as an arc the modified arrangement shown in Fig. 2 is recommended. L. H. W.

1347. *Dynamo suitable for use in Wireless Telegraphy.* **P. Villard.** (Comptes Rendus, 145. pp. 889–891, Aug. 12, 1907. Ind. Élect. 16. pp. 428–429, Sept. 25, 1907. Electrician, 59. p. 1081, Oct. 11, 1907. Abstract.)—The author first points out that for high-power work where alternating current is generally the source of energy employed, the rapid succession of sparks obtained when the usual frequencies are used (50–100 ∼ per sec.) leads to a considerable waste of energy. It is true that the method of "rarefaction" of the spark may be adopted, of which Blondel has lately given the full theory [Abstract No. 889 (1907)], but even then accurate regulation is required and the waste of energy is by no means negligible. He then describes a new

form of generator capable of furnishing a voltage curve similar to that given by an induction coil and giving discharges succeeding one another at a suitable and regulable interval. The generator is of the inductor type, the external fixed part having only two diametrically opposite coils of small angular width. The rotating inductor is provided with 4 poles, each pair being close together, like the letter H. During half the revolution the poles do not pass any coil and the energy expended is only that due to the iron losses. The whole output is produced during a small fraction of a revolution and hence greatly exceeds that of an alternator of the same mean power, thus rendering the employment of resonance unnecessary. Oscillograms

show that the max. voltage is three times the effective (r.m.s.) voltage. When supplying a voltage of 50 to the primary of a transformer of ratio 2,000, a 5-cm. spark is obtainable, and if the transformer is connected to an antenna, a 10 or 12-cm. spark. The three oscillograms reproduced show U_0, the no-load voltage and current curve (through ohmic resistance); I_1 and U_1 respectively the current and voltage curves at the transformer when charging a condenser joined to a spark-gap. L. H. W.

1348. *New Method of Generating High-frequency Currents.* **R. Rüdenberg.** (Phys. Zeitschr. 8. pp. 668–672, Oct. 15, 1907. Inst. f. angewandte Mechanik, Göttingen, Sept., 1907. Écl. Électr. 53. pp. 171–172, Nov. 2, 1907.)—Let a condenser of capacity C be connected across the terminals of a series-wound generator, and let the resistance and self-inductance of the circuit be denoted by r and L respectively. Let it be further assumed that the e.m.f. of the generator is proportional to the current i, and given by ki. The equation of current is then—

$$\mathrm{L}\frac{di}{dt} + ri + \frac{1}{\mathrm{C}}\int i\,dt = ki,$$

the solution of which is—

$$i = \mathrm{I}e^{-\frac{r-k}{2\mathrm{L}}t} \cdot \sin\left(\sqrt{\frac{1}{\mathrm{CL}} - \left(\frac{r-k}{2\mathrm{L}}\right)^2} \cdot t + \phi\right).$$

The total resistance r may, if desirable, include an adjustable resistance in the external circuit. Three cases may arise, viz.: (1) $r > k$; it is evident that owing to damping the current will soon disappear; (2) $r = k$; the oscillations will be maintained, and will have a frequency which is quite independent of the speed of the generator; (3) $r < k$; the current will increase up to a certain limit, but will finally settle down to some value, and the oscillations will be maintained; the current cannot obviously increase indefinitely, as saturation of the iron decreases k, and increase of current increases r. It is desirable to use a generator having a laminated field in order to reduce the

eddy-current losses. The power supplied by the generator to the circuit just makes up for the various losses by heating and electromagnetic radiation; and oscillations of a definite period, depending solely on the self-inductance of the generator and capacity of the condenser, are maintained in the circuit. In the author's experiments, the small ($\frac{1}{10}$ h.p.) generator employed was found to be completely demagnetised each time it was stopped, and it was found necessary to give it a start when running by means of a secondary cell which could be momentarily connected across its terminals. The author points out that if such an asynchronous generator be made to supply energy to a system capable of several modes of vibration having different frequencies, then on account of the more powerful damping which invariably accompanies a higher frequency, the oscillations of higher frequency will all be damped out, so that in the steady state only the fundamental oscillation will survive. The most advantageous arrangement of this type of generator is as follows. The field is entirely disconnected from the armature, and is joined in series with the condenser (a regulating resistance being included in the circuit if necessary); the armature is short-circuited, and the brushes are displaced from their neutral position as in the repulsion type of single-phase commutator motor. For such an inductive coupling of armature and field as against the simple series connection the author claims the advantages of better commutation and reduction of the self-inductance in the oscillating circuit, which allows of higher frequencies being attained. The use of the arrangement described as a *receiver* is next considered by the author. Let the speed of the generator be so adjusted that it just fails to maintain the oscillations, the power which the generator is capable of supplying falling short by a very small amount of that required to cover all the losses. Then the system is one possessing an extremely small amount of damping, and will in consequence have a very large and sharply marked maximum in its resonance curve. It is therefore very well adapted for use as a receiver in tuned systems of wireless telegraphy. The antenna would in such cases be connected to one terminal of the condenser, the other terminal being earthed. A. H.

1349. *Experiments on Damping in Wireless Telegraphy.* **K. E. F. Schmidt.** (Phys. Zeitschr. 8. pp. 619–624, Oct. 1, 1907.)—The experiments were carried out with a distance of only about one wave-length between transmitter and receiver. The following is the author's summary of the results. (1) Arrangements of transmitter and receiver circuits are described which give the lowest possible damping (substitution of counterpoise for the earth). (2) Measurements are given showing the marked influence of atmospheric conditions upon the transmission of the electric waves. (3) It is shown that the effect at the receiver is greatest with earthed systems. (4) The effect of the position of the wire connecting the antenna to earth is considered. L. H. W.

1350. *Losses in Condensers and Damping in Wireless Telegraphy Circuits.* **W. Hahnemann and L. Adelmann.** (Elektrotechn. Zeitschr. 28. pp. 988–990, Oct. 10, and pp. 1010–1011, Oct. 17, 1907.)—The authors employ Zenneck's modification of Bjerknes' method for their investigation ("Elektromagnetische Schwingungen," p. 625). It is found that, as compared with an air condenser, the condenser losses (here called $\Delta\delta$ = the increase of the damping of the oscillatory circuit due to such losses) in all cases examined increase with increase of the specific loading (the watts $\times 10^{-4}$ per discharge

per c.cm .of solid dielectric). In the second part a comparison is made of the losses in different solid dielectrics. Curves plotted between specific loading and $\Delta\delta$ yield in all cases straight lines, of varying inclination, hence these can be written $\Delta\delta = \alpha A + \beta$, where $A =$ watts $\times 10^{-4}/\text{cm.}^3$ per discharge and thus depends upon the specific loading of the condenser; α is the tangent of the angle made by the curve with the axis of abscissæ, and β is ordinate at the point of intersection of the curve with the axis of ordinates. With the help of the table of constants for α and β the damping decrement of any arrangement of similar equal condensers, p in parallel and h in series, can be calculated by the formula, $\Delta\delta = (h/p)(\alpha A + \beta)$ at any specific loading:—

Mark.	Material.	α.	β.	Mark.	Material.	α.	β.
a	Indiarubber	20	0·0264	*e*	Paper	8·85	0·0570
b	"	28	0·0165	*f*	Celluloid	7·38	0·0725
c	"	8·8	0·1280	*g*	Ebonite	2·10	0·1900
d	"	1·72	0·0710	*h*	Mica	28·7	0·0935

By the use of these results it is now possible to calculate the damping due to the spark alone, *i.e.*, with the condenser losses first deducted. In glass condensers, which are next investigated, it is found that there is an external as well as an internal damping. This external damping is chiefly due to the edge discharge and the nature of the material of which this edge is composed. The total damping does not increase much with increase of specific loading if the condenser is immersed in oil, thus getting rid of the "brushing" at the edge. L. H. W.

1351. *New Detector for Wireless Telegraphy.* (Elect. Engineering, 2. p. 688, Oct. 24, 1907.)—The patent specification of R. A. Fessenden's Brit. Pat. 4,714 of 1907 is reproduced. Stripped of its ornamental language, the apparatus employed consists of an electrolytic detector located within the lower of two communicating vessels containing the electrolyte, a constriction being provided in the communicating pipe. It is claimed that by the use of unequal-sized electrodes (one at least very small) the gas evolved by the oscillatory current will at once break away and block the constriction in the communicating pipe, thus interrupting the local circuit and giving rise to a sound in the telephone. A sectional diagram is given, but no particulars as to speed of operation, &c. L. H. W.

1352. *Distortion in Telephonic Transmission.* L. Cohen. (Electrical World, 50. pp. 564–565, Sept. 21, 1907.)—The most important factor to be considered in telephonic transmission is distortion, especially when long distances are dealt with. It arises from the fact that an electric wave in its passage along a conductor is attenuated, and the attenuation is a function of the frequency, so that every harmonic is attenuated to a different degree and the space wave is distorted. [Abstracts Nos. 595 and 972 (1907).] The author considers that all previous investigators have assumed, at least by inference, that the constants for the line are the same for all frequencies. But for the frequencies involved in telephonic work, he holds that there is a very important variation in the resistance of the conductor. Numerical examples are given, and it is shown that the difference in attenuation between a frequency of 200 and 2,000 will be about 7 per cent. This would account

for nearly all the trouble, and, from this consideration, it would result that, even if it were possible to realise in practice the relation between the constants set forth by Heaviside, as corrective of distortion, this latter would still exist. Incidentally, the author suggests the use of stranded wire for long-distance telephony; for the change in resistance varies as the fourth power of the radius, and consequently by diminishing the radius we diminish the change in resistance. E. O. W.

1353. *Telegraphy and Telephony at the Milan Exhibition.* **A. Carletti.** (Journ. Télégraph. 30. pp. 245–246, Nov., and pp. 269–274, Dec., 1906; 31. pp. 8–12, Jan.; 29–34, Feb.; 65–69, March; 91–98, April; 118–119, May; 143–146, June; 169–172, July, 199–203, Aug., and pp. 221–224, Sept., 1907.)—Some of the apparatus described has already been noticed in previous Abstracts. A. Battaglia exhibited his modification of the Hughes. In his system the problem of transmission on lines of large electrostatic capacity is dealt with by a mechanical method [see Abstract No. 1343 (1907)]. Each working impulse, for example positive, is preceded and followed by an impulse of the same duration but of contrary sign, in this case negative. For cable work the line is blocked at the two extremities by condensers, and matters are so arranged that a time-interval separates the working impulse from that due to the position of rest, in order to permit of due propagation of the sign. For very long cables the emission from the rest position is suppressed, and the working impulse is preceded by a neutralising one. The mechanism by which this is achieved is described. An electric stamping machine ("dateur") by the Deutsche Telephonwerke provides for impressing on telegrams or telephonic bulletins all the necessary preamble of service. It is composed essentially of a certain number of type wheels, moved automatically and at regular intervals of time. The day, hour, and minute is indicated by clockwork, precisely regulated, which, by the employment of a relay, controls the type wheels. The clockwork is not necessarily mounted with the date stamp, but a number of these can, if desired, be connected simultaneously to a master clock at a distance. The apparatus functions in the following way. Each minute the clock produces a contact which closes the relay circuit, by which all the electromagnets controlling the type wheels and joined in parallel are momentarily excited, and by means of levers and ratchets the type wheels are moved into place. The impression on the message form is caused by the armature of a second electromagnet, which, being connected to a metallic plate, causes the form to be pressed against the types and inking ribbon, when the clerk presses a button. Forty of these instruments have been installed in the central telegraph office at Berlin, and are giving satisfaction. E. O. W.

1354. *Telephonic Transmission Measurements.* **B. S. Cohen and G. M. Shepherd.** (Inst. Elect. Engin., Journ. 39. pp. 503–533; Discussion and Communications, pp. 533–565, Sept., 1907. Electrician, 59. pp. 124–126, May 10; 182–183, May 17; Discussion, pp. 231–233, May 24, 1907. Abstract.)—This is an important paper dealing with quantitative measurements with the high-frequency oscillograph of Duddell, used in conjunction with the falling photographic plate arrangement. Oscillograms of speech waves are shown, and of the effects of attenuation and distortion of waves over telephone lines. Some tests carried out on loaded lines led to an interesting method of ascertaining the highest important frequency in articulate speech. If the spacing, *i.e.*, distance apart, of loading coils is increased, and, at the same time, the amount of inductance per mile

inserted is unchanged, the attenuation-constant also increases gradually, and at one particular spacing increases to an enormous extent. Curves are exhibited for the variation of attenuation-constant with spacing for frequencies of 800 and 1,600 $\sim$ per sec. These curves were calculated from formulæ by G. A. Campbell, and have been confirmed by tests made with a sine-wave alternator. As the articulation of a received telephone wave depends to a very great extent on the attenuations of the harmonics present, it was thought that the application of the arrangement just referred to would help to settle the question as to which frequencies determine by their presence or absence the difference between articulate and inarticulate transmission. A series of articulation observations were consequently made on 20 miles of cable for increasing spacing intervals with a constant load of 0·17 henry per circuit mile, and commencing with a distribution of 1 load per mile. It was found that a 2-mile load was very slightly inferior to the unloaded line of equivalent speaking volume, but still gave excellent commercial transmission. This indicates that harmonics above 1,000 $\sim$ may be dispensed with. With 8-mile distribution the articulation was commercial, but decidedly inferior to the unloaded line. The critical frequency for this disposition of the load was about 1,100 $\sim$, and it is thus apparent that harmonics between 1,100 $\sim$ and 1,600 $\sim$ are valuable. For 4-mile intervals speech became quite impossible, although the volume was still quite considerable, and it must therefore be concluded that the highest indispensable frequency lies between 800 and 1,100 $\sim$ and that it is desirable to retain something higher than 1,100 $\sim$ for really high-grade transmission. A series of models illustrating in a topographic manner the variations of potential, current, and phase relations along a transmission line have been constructed and are shown diagrammatically. Among other deductions in the course of these investigations is that there is probably a very considerable reduction in the effective insulation of paper cables at telephonic frequencies. In the *discussion*, **A. Campbell** notices this last point. From experiments made with cellulose in the air-dry condition, with a considerable amount of moisture present, the cellulose had a very much larger effective resistance for low than for high frequencies. In the case of the well-dried paper cable he thinks the minute traces of associated moisture in the cellulose account for this change of effective resistance. The most thorough drying always appears to leave a certain amount of moisture in the paper. An experiment by this speaker showed that a microphone gives strong resonance with certain frequencies, which makes it surprising that speech can be transmitted so well. **J. E. Young** dealt with the importance of the application of non-inductive leaks to telephone circuits. In the distortionless circuit all the frequencies are received with equal attenuation, when the leakage has a particular value. This theoretical value, however, diminishes the volume too much. The critical artificial leakage value should be investigated. It is probably in the order of a few tens of thousands of ohms per mile, or less. **J. Gavey** remarked that in a number of experiments the Post Office made some six years ago in loading the underground trunk lines, if the inductances were spaced at distances of about 2 miles the results were excellent. The mathematical results obtained by the authors give about the same figure. The closer the spacing the more distortionless the wave; on the other hand, spacing may be so close that it would pay better to use a larger conductor and to do away with the loading. **W. Duddell** displayed oscillograms of certain vowel sounds in relation to the actions of the vocal organs, and described a high-frequency sine-wave alternator which he had devised.

At 500 or 600 ∿ per sec. he was able to get a really good sine wave and an output of 10 to 20 watts. An alternator for 120,000 ∿ had been made giving the same type of wave-form as represented by the authors. [Abstract No. 1282A (1905).] A wave filter, to correct a bad wave-form, was also referred to. E. O. W.

REFERENCES.

1355. *Experiments with Concrete Telegraph Poles.* **G. A. Cellar.** (Elect. Rev. 61. p. 277, Aug. 16, 1907. Abstract of paper read before the Convention of Rly. Telegraph Superintendents at Atlantic City, N.J. Electrician, 60. pp. 1039–1040, Oct. 11, 1907.)

1356. *The Suspension of Overhead Wires.* **G. Nicolaus.** (Elektrotechn. Zeitschr. 28. pp. 896–901, Sept. 12, and pp. 918–922, Sept. 19, 1907. Communication from the Kaiserl. Telegraphen-Versuchsamt.)—This paper deals, in an extensive manner, with the values for bronze and for iron wires, of the dips and strains for varying lengths of spans, taking into consideration the effect of change of temperature and the coefficients of elasticity. The results of the calculations are given in curves and in tables. For these reference should be made to the paper, as they cannot be conveniently abstracted. E. O. W.

1357. *Wireless Telegraphy between Newhaven and Dieppe.* (Engineering, 83. pp. 308–310 and 312, March 8, 1907.)—Illustrated description of the stations and connections (Rochefort system). L. H. W.

1358. *Production of Continuous Waves for Wireless Telephony.* **A. Blondel.** (Rev. Électrique, 8. pp. 74–75, Aug. 15, 1907. Paper read before the Assoc. franç. pour l'avancement des Sciences, at Rheims. Écl. Électr. 52. pp. 429–430, Sept. 21, 1907.)—The author claims that he and not Poulsen was the originator of the method of producing continuous oscillations, and attempts to support his claim by reproducing the substance of specification of his Brit. Pat. 15,527 of 1902—in which, however, the essential point appears to be the prevention of the spark discharge from turning into an arc. L. H. W.

1359. *Propagation and Interception of Energy in Wireless Telegraphy.* I. **C. A. Culver.** (Phys. Rev. 25. pp. 200–223, Sept., 1907.)—A very detailed account of experiments made to investigate the relative efficiency of different type of receiving systems. In view, however, of the fact that the wave-lengths employed were of 500–580 m., while the distance between the transmitting and receiving stations was only 47 m. (with a building interposed), the results obtained cannot well be taken as applying to actual wireless transmission; the interested reader should therefore consult the original pages for the useful information as regards the tuning and instrument details. L. H. W.

1360. *Non-earthed Loop for Wireless Telegraph Reception.* **L. de Forest.** (Electrician, 59. p. 807, Aug. 30, 1907.)—Referring to Pickard's use of a non-earthed closed loop [see Abstract No. 970 (1907)], the writer claims that he has previously described such a receiving circuit in U.S. Pat. 771,819, and also the horizontal receiving antenna described by Marconi. [See Abstract No. 887, (1904)]. L. H. W.

1361. *Antennæ for Wireless Telegraphy.* (U.S. Pat. 860,051. Electrical World, 50. p. 193, July 27, 1907. Abstract.)—J. Murgas proposes to employ an elevated aerial wire which extends down a considerable distance into the earth (in a sort of well) and is insulated therefrom. L. H. W.

SCIENCE ABSTRACTS.

Section B.—ELECTRICAL ENGINEERING.

DECEMBER 1907.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

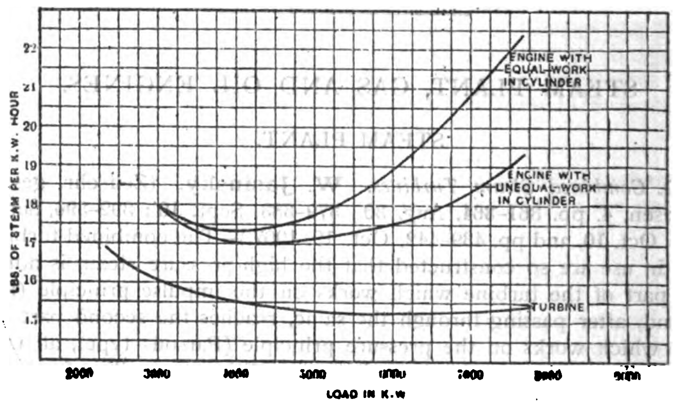
1362. *Combined Steam Turbines.* **W. Jasinsky.** (Zeitschr. ges. Turbinenwesen, 4. pp. 361–364, Aug. 30; 379–383, Sept. 10; 392–396, Sept. 20; 421–426, Oct. 10, and pp. 439–442, Oct. 19, 1907.)—The combined turbines at present in use are so constructed that the high-pressure steam is admitted to that part of the turbine which works on the impulse principle (Rateau type), and, after passing through the same, reaches the second part of the turbine, which works on the pressure principle (Parsons type), at a lower pressure. The author works through the conditions prevailing from admission to exhaust, for each pressure stage and blade wheel for the Rateau and Parsons types respectively, and with the aid of the Mollier diagrams and various formulæ for friction losses, &c., arrives at the efficiency for each step. The results are tabulated. By comparison of the results for the two types, the best method of combining the two types is found to be the following: The first half should be constructed on the Parsons principle (with 55 steps in the particular case chosen), and the second half on the Rateau principle (with only 12 steps). The thermodynamic efficiency of the whole combined turbine is then calculated and found to be 76 per cent., whereas the calculated thermodynamic efficiency of the Rateau turbine (27 steps), of the same output and speed, was 73 per cent., and that of the Parsons turbine (68 steps) 71·6 per cent. H. M. H.

1363. *Effect of Altitude on Steam Power.* **O. H. Mueller.** (Power, 27. pp. 751–752, Nov., 1907.)—The author merely considers the effect of a difference of pressure corresponding to 30-in. and 24-in. barometer upon a steam engine, and shows that at the lower pressure 35 per cent. more condensing water would be required and a much larger air-pump than at the higher pressure. The cooling-water is supposed to be supplied at 70° F. in both cases. A diagram is given showing that whilst the position of the atmospheric line is changed relatively to the lines of zero and initial steam pressure, yet the outline of the diagram for exhaust into a condenser is unchanged. The non-condensing engine, however, gains in power when the barometer is low. [See also Abstract No. 1272 (1906).] F. J. R.

1364. *Recent Tests of Large Curtis Turbines.* (Street Rly. Journ. 30. p. 452, Sept. 28, 1907.)—Tests of one of four 9,000-kw. generating units installed at Fisk Street station of the Commonwealth Electric Co. at Chicago have given the following results :—

Load in Kw.	Gauge Pressure, lbs.	Vacuum, in.	Superheat, deg. F.	Water Rate, lbs. per kw.-hour.
5,374	182	29·45	138	13·15
8,070	179	29·55	116	13·0
10,186	176	29·47	147	12·9
12,108	182	29·34	148	13·05
13,900	198	29·31	140	13·6

A test at Boston, on Jan. 29, 1907, on a 2,000-kw. five-stage, 720-r.p.m. machine, under full-load conditions, gave the following: Load on generator,



5,915 kw. ; steam pressure, 173·7 lbs. ; vacuum, 28·8 in. ; superheat, 142° F. ; steam consumption, 13·52 lbs. per kw.-hour. Curves are given (see Fig.) showing comparison between the Boston turbine and a 5,000-kw. compound engine unit working under the same conditions, and the advantages of the turbine under overload conditions are further illustrated by other curves showing results from a 2,250-kw. and a 1,000-kw. machine at Schenectady.

F. J. R.

1365. *Determination of the Efficiency of Steam Turbines without Measurement of Steam Consumption or Output.* **F. Langen.** (Zeitschr. ges. Turbinenwesen, 4. pp. 433–437, Oct. 19, 1907.)—If a turbine is supplied with saturated steam, and the admission and exhaust pressures are known, the amount of heat energy theoretically converted into mechanical energy per kg. of steam can be calculated or obtained from the Mollier or Proell diagrams. If the steam is superheated the temperatures at admission and exhaust must also be known. Although from 25 to 27 per cent. of this mechanical energy is absorbed by wheel- and blade-friction losses, this amount is reconverted into heat and given up to the steam again, so that the exhaust steam contains an excess of heat over that calculated by an amount equal in value to the internal steam friction loss. If the admission temperature and pressure are measured, the amount of heat energy in kg.-cals. per kg. of steam admitted can be easily calculated ; and if the steam is still slightly superheated at the

exhaust, the amount of heat energy in kg.-cals. per kg. of steam given up to the condenser can also be calculated. The difference between these two amounts is the heat energy in kg.-cals. per kg. of steam actually converted into mechanical energy. By dividing this value into 687 the steam consumption in kg. of steam per h.p.-hour is directly obtained (one (Continental) h.p.-hour = 687 kg.-cals.). The ratio of the above value of the heat energy actually converted into mechanical energy to the value obtained from the Mollier diagram is the thermodynamic efficiency of the turbine. If the exhaust steam is not at all superheated, the amount of heat energy per kg. of steam given up to the condenser is not easy to obtain, as in such a case this value must be obtained by measuring the quantity and temperature of the cooling water. For non-condensing turbines only a small amount of superheat is necessary in order that the exhaust steam may be slightly superheated. A table giving the conditions (admission pressure, superheat, and efficiency) under which a slightly superheated exhaust may be expected, for turbines of various sizes, is included in the article. The thermodynamic efficiency obtained by the method described will be somewhat too high, as the radiation and bearing friction losses have not been taken into account. These last are, however, easily estimated. The bearing friction loss may be taken as 0·2 to 0·5 per cent., and to this must be added another 0·5 per cent. for power taken by the oil-pump and governor. The radiation losses are also very low; for direct-coupled turbines the sum of the above losses can be taken as from 1 to 2 per cent., and consequently the above efficiency must be decreased by this amount. The gear loss, in the case of de Laval turbines, brings this amount up to 8 per cent. to 15 per cent. This method of measuring the efficiency and steam consumption of steam turbines will be found useful where the turbine is directly coupled to a machine of unknown efficiency, and in other such cases where the output of the turbine cannot be directly measured. In the case of turbines with two or more pressure-stages the efficiency of each stage can be determined by the above method.

H. M. H.

1366. *Tests of Ribbed and Plain Hollow Cylinders.* **C. Bach.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1700–1704, Oct. 26, 1907.)—Describes tests under internal fluid pressure of three cast-iron cylinders of the form used for steam turbines, of which particulars are given in the following table:—

Cylinder.	A.	B.	C.
Diameter, internal, about	500 mm.	500 mm.	500 mm.
Length, about	1,450 „	1,450 „	1,450 „
Thickness of wall, about	20 „	20 „	20 „
Number of circumferential ribs	0	5	5
Number of longitudinal ribs	0	8	8
Height of ribs	—	50 mm.	100 mm.
Relative weight	1·00	1·55	2·10
Bursting pressure, atmospheres	100	129	140
Elastic strain (increase of central diam.) at 80 atmos. pressure	0·475	0·32	0·315

The usual low estimate of the increase of strength due to addition of ribs to a cylinder is thus considered to be justified. The use of ribs of moderate height is an advantageous method (from the point of view of economy of

material) of reducing bulging under pressure. The bursting stress in A, calculated on the ordinary thin cylinder formula was 1,265 kg. per sq. cm.; the ultimate stress in tensile tests averaged 1,760 kg. per sq. cm. F. R.

1367. *Cost of Power.* **C. T. Wilkinson.** (Power, 27. p. 748, Nov., 1907.)—The author gives a table, compiled by R. H. Fernald, of comparative estimated costs of steam- and gas-power plants for a 600-h.p. plant in one unit, and a 6,000-h.p. plant in three units of 2,000 h.p. each, using coal at $2.75 and $2.50 per gross ton. In the 600-h.p. plant the first cost of gas plant is taken at $48,000, and of steam plant at $40,000—the total operating costs per annum are, however, $8,102, as against $14,578. Total operating and fixed charges are $16,262 and $21,878, and the cost per kw.-hour (operating 300 days × 24 hours) is $1.05 and $1.38. In the larger installation first cost is the same, $420,000, for both kinds of plant. Total operating expenses for gas plant, $70,375; and for steam, $147,955. Total operating and fixed charges, $141,775 and $219,355. Cost per kw.-hour (operating 365 days × 24 hours), $0.55 and $0.85. A load factor of 75 per cent. is assumed in the latter case, and in the smaller installation one of 75 per cent. for 10 hours and 33½ per cent. for 14 hours. The same quality of coal is assumed for both steam and gas plants. F. J. R.

1368. *The Hydrogen of Coal.* **F. F. Grout.** (Amer. Chem. Soc., Journ. 29. pp. 1497–1499, Oct., 1907.)—In all bituminous coal, also in black and brown lignites, the proximate analysis and estimation of total carbon, yield sufficient data for the calculation of an ultimate analysis in which no error would seem to be above 1 per cent. and the average error would be much less than this. The higher errors would be in oxygen and nitrogen, which are of little account from the calorific point of view. The hydrogen of pure coal (*i.e.*, coal free from ash and moisture) is 5·38 per cent., with an average error of only 0·16 per cent. In a coal-field of limited area the ***maximum*** error is undoubtedly often less than 0·51 per cent. When it is possible to obtain the proximate analysis and percentage of carbon more easily than the calorific value, a fairly close calculation of the latter may be made by aid of Dulong's formula and the estimated ultimate analysis obtained in the manner suggested above. As recent experimental work on fuels indicates that Dulong's formula when used in this way yields low results, it is proposed that 0·17 per cent. be added to the figures obtained by calculation for the available hydrogen in the ash and water free coal, before calculating the calorific value. Then, in cases where no ultimate analysis of the coal can be carried out, this estimated ultimate analysis gives the best foundation known for calculating the heat value of the fuel. The special advantage of this method, however, would appear to be confined to those cases in which the determination of the carbon is found to be more easily made than the direct calorific test. [See also Abstract No. 607 (1907).] J. B. C. K.

1369. *Uehling's CO_2 Apparatus.* (Power, 27. pp. 404–406, June, 1907.)—The Uehling "Gas Composimeter" for determining and recording the amount of CO_2 in flue gases is based upon the law governing the flow of gas through two small apertures. Two gas-containing vessels of different capacities are placed in connection with a steam-jet aspirator and with the flue, and the apertures connecting the smaller vessel with the other, and the second larger vessel with the flue, are small and of equal size. When the aspirator is set to

work a partial vacuum is produced in both vessels, consequent upon the fact that gas is being drawn out of them more quickly than it can enter; and the vacuum as measured by manometers attached to each vessel will be twice as great in the smaller as in the larger vessel. If now the gas passing through the larger vessel be submitted to the action of a solvent which absorbs and withdraws one of its constituents, the vacuum in the second chamber or vessel will be increased, and the difference between the partial vacuum in the two vessels will be diminished in like ratio. The absorption of CO_2 from furnace gases by caustic potash can therefore be utilised, to cause differences in the pressure ratios in the two gas-vessels; and by proper calibration a means for ascertaining the percentage of CO_2 in the furnace gases is obtained. To embody this principle in a practical apparatus the following conditions must be fulfilled. (1) The gas must be brought into the apparatus under a constant tension, and must be drawn through the two apertures with a continuous and uniform suction. (2) Both apertures must be located in a part of the apparatus which is maintained at a constant temperature. (3) Provision must be made for keeping these apertures perfectly clean. (4) The larger chamber must be made perfectly gas-tight. (5) The constituent to be absorbed must be entirely removed while the gas is passing through this part of the apparatus. The Uehling "Composimeter" fulfils these conditions, and is continuous in its operation. It can be arranged to give both direct readings and automatic records. In its practical applications the main apparatus and recorder are placed in any convenient spot within reasonable distance of the boilers; but the indicators are placed on or near the boiler, in full view of the foreman, who can thus see at a glance the percentage of CO_2 in the exit gases. J. B. C. K.

1370. *New Torsion Meter.* **B. Hopkinson** and **L. G. P. Thring.** (Engineering, 83. pp. 768–770, June 14, 1907. Mech. Eng. 19. p. 880, June 22, 1907.)—Gives some discussion of the type of dynamometer which measures the twist in a length of shaft. The authors' instrument measures the twist in only a small length, 1 to 2 ft. of shaft; the relative rotation of two sections at the chosen distance apart is caused to tilt a mirror carried upon the device and rotating with it. The reflection of a source of light from this mirror is received upon a scale once in each revolution of the shaft. The two pieces which transmit the relative rotation to the mirror are a sleeve and a collar, respectively, each clamped to the shaft by three round-ended screws in one plane. The sleeve is in contact with the collar at three points in the plane of the clamping screws of the collar. The mirror axis is also in this plane, and carries a bearing ball at its outer end, receiving the movement of the sleeve through a plate. In this manner the mirror receives no movement except when the shaft is twisted. An accuracy of 1 per cent. is possible with the instrument. Its satisfactory use in the trials of the torpedo boat *Greenfly* is described. F. R.

1371. *Aluminium Alloy.* (U.S. Pat. 856,892. Electrochem. Ind., N.Y 5. p. 285, July, 1907.)—A. Chambaud claims an alloy of the following percentage composition: Al 99·02, Fe 0·81, Zn 0·01, Mg 0·041, Cu 0·61. It is said to be very tenacious, ductile, and malleable; it can be welded and cut with ordinary tools. F. R.

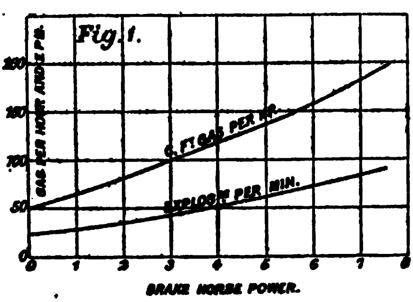
1372. *Copper-Zinc Alloy.* (U.S. Pat. 854,462. Electrochem. Ind., N.Y. 5. p. 242, June, 1907.)—G. E. Buttenshaw patents an alloy suitable for fittings

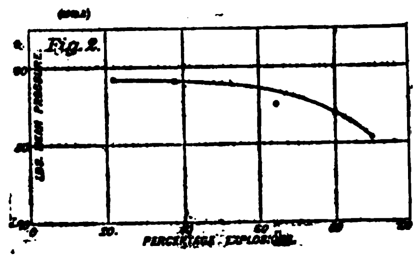
which come in contact with sea-water, which is not liable to oxidise or set up galvanic action with iron or steel. The approximate percentage composition is: Cu 40–48·19, Zn 41–48·86, Ni 10–10·20, Pb 1–85, phosphor tin 1, Al 0·15.

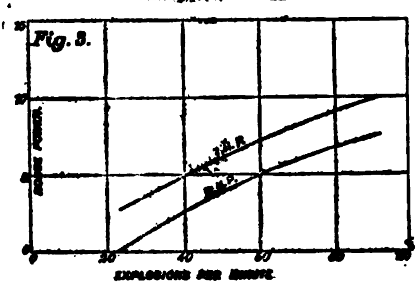
F. R.

GAS AND OIL ENGINES.

1373. *Thermal and Power Losses in Internal Combustion Engines.* **A. H. Burnand.** (Engineering, 84. pp. 445–446, Oct. 4, and pp. 509–510, Oct. 18, 1907.)—In a former paper [Abstract No. 905 (1906)] the author investigated the friction losses in gas engines. The present investigation was carried out with the same engine in the mechanical laboratory of Hartley University College, the engine having cylinder $6\frac{1}{4}$ in. diam., stroke 15 in., nominal r.p.m. 200; compression pressure about 64 lbs. above atmospheric







and governing by "cutting out." In investigating the effect of load only, upon mean pressure obtained, the r.p.m. being kept as steady as the governor would permit, the author found that the curve of explosions per min. plotted upon a b.h.p. base, from being fairly straight at its commencement, showed a rapidly increasing upward slope as the b.h.p. approached its limit, the curvature commencing to be pronounced where the engine was making half its max. possible number of explosions per min. This is shown in the lower curve of Fig. 1. As the load increased from this point so also would the number of consecutive explosions and with them a general lowering of the mean pressure. The inference was that at any given load, other conditions being constant, the mean pressure would be governed by the percentage explosions per min. of the max. number then possible. This is illustrated by Fig. 2, showing mean pressures obtained during a progressive power test plotted on a base of percentage explosions per min. Fig. 3 shows that the b.h.p. does not increase at the same rate as the explosions per min., and also to what extent loss of power occurs. The upper curve in Fig. 1 shows that the gas consumption per i.h.p.

increases at a greater rate as the load becomes heavier, and consequently a fall of thermal efficiency is bound to result. Investigating the quantity of charge admitted, it is shown that a very small addition of heat causes great variation in the ratio of air to gas, with attendant effects upon mean pressure. The general conclusions are: (1) A steady fall of mean pressure takes place as explosions become more continuous. (2) The fall is connected with increased percentage of possible explosions rather than mere number per min., the condition becoming serious after 50 per cent. is exceeded. (3) The replacement of air by burnt gases and reduction of amount of air by heating cause great variations in the proportions of the charge and are due to the increase of percentage of possible explosions. In the second portion of this article the conditions arising in engines running at a variable speed without missing any explosions are investigated and the general conclusions are summarised as follows: (1) No ordinary design of engine draws in a charge equal to the piston displacement when reduced to atmospheric pressure (temperature neglected). If temperature effect is included its amount is considerably reduced when referred to atmospheric pressure and temperature. Great losses of power occur from insufficient valve area or unsuitable valve setting, but the former does not necessarily affect thermal efficiency upon i.h.p. (2) The work done may be taken as directly proportional to charge admitted, its ratio being unchanged and ignition-point such as to give best result. (3) Engine friction increases considerably with r.p.m., and consequently lowers both mechanical and thermal efficiency on b.h.p. Some deductions from these follow in the paper. Diagrams are given in this part of the paper to illustrate the effects produced by valves and by friction. F. J. R.

1374. *A Year's Experience with Gas Engines.* **P. Winsor.** (Street Rly. Journ. 30. pp. 725–726, Oct. 19, 1907. Eng. Record, 56. p. 434, Oct. 19, 1907. Paper read before the Amer. Street and Interurban Rly. Engineering Assoc.)—The gas plant at Somerville power station of the Boston Elevated Railway Co.—consisting of a pair of Loomis-Pettibone gas producers; two 600 b.h.p. Crossley gas engines, each 2-cylinder 4-cycle; two 350-kw. Crocker-Wheeler generators—was started in May, 1906, and tabulated results of its working from Jan. to July of 1907 are given. The averages are: lbs. coal per kw.-hour, 2·084; lbs. coal per b.h.p.-hour, 1·404; station load-factor based on 16 hours per day and 7 days per week, 41·6 per cent.; engine load-factor, 88·8 per cent.; generator load-factor, 98·35 per cent. Average amount of water used for scrubbing gas and cooling purposes, 281 lbs. per kw.-hour. Each unit has carried 450 kw. (652 b.h.p.) for an hour, with swings to 495 kw. (717 b.h.p.). The average coal per kw.-hour (2·084 lbs.) as against the coal used by steam plant in same time, viz., 3·477 lbs. per kw.-hour, shows 41·5 per cent. economy. The service has been continuous, reliable, and satisfactory, with no shutdowns, no accidents and no failures. The drawbacks to gas plant are—first cost approximating $200 per kw. when rated so as to have a 33⅓ per cent. overload capacity; and small size of units, the largest gas engine now built being only of about 3,000 kw. capacity. F. J. R.

1375. *Contact Method of Gas-engine Ignition.* **E. J. Edwards.** (Electrical World, 50. pp. 765–767, Oct. 19, 1907. Écl. Électr. 53. pp. 340–341, Dec. 7, 1907.)—The author investigates the theory of that method of ignition which consists in making the circuit of a battery of dry cells through an

inductive resistance, and then breaking it so as to obtain the ignition spark. The results arrived at (and confirmed by experimental investigation) are as follows. The shorter the time of contact, the higher the inductance; and the smaller the resistance, the more efficient is the operation of the system. If perfect ignition is to be obtained at the least cost per year, the number of hours that the engine is kept running per day must be taken into account; when this number is small, electrical efficiency may be sacrificed in order to reduce the cost of maintaining the battery. The inductance should be rather high in all cases—never less than 0·05 henry. When a battery of few cells is used, the time of contact must be made long in order to obtain sufficient spark energy. With a large number of cells, the period of contact may be made short, the efficiency being thereby increased. A. H.

AUTOMOBILISM.[1]

1376. *Gyroplane Flying Apparatus.* **L. Breguet, J. Breguet,** and **C. Richet.** (Comptes Rendus, 145. pp. 523–524, Sept. 16, 1907.)—Description of a new apparatus called the Gyroplane, in which the properties of gyratory systems are employed to obtain lifting power. Using a motor of 40 h.p., weighing 170 kg. the total weight of the apparatus was 540 kg. (including that of the aeronaut, 70 kg.). The total surface of the 32 wings, arranged in four gyratory systems, was 26 sq. m. Each of the systems attained a velocity of 78 revs. per min., the circle described by the periphery of the wings was 8·1 m. in diam., corresponding to a linear velocity of 26·4 m. per sec. Under these conditions the apparatus easily rose to a height of 0·60 m. from the ground, and was maintained there for about one minute. C. P. B.

REFERENCES.

1377. *Turbo-compressor.* **W. Schüle.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1669–1672, Oct. 19, 1907.)—Fürstenau has given a description of researches with a Parsons turbine-blower, in which he found a greater efficiency than for two piston-type blowers [see Abstract No. 990 (1907)]. The present paper is a criticism, based on the principles of thermodynamics, of turbo-compressors in general. A. W.

1378. *Spontaneous Ignition of Balloons.* **W. de Fonvielle.** (Comptes Rendus, 145. pp. 108–109, July 8, 1907.)—Referring to recent explosions, both on ascending and on descending, the author attributes them to the practice of "metallising" the network with aluminium wire, which makes the capacity of the balloon equal to that of a sphere of the same diameter. E. E. F.

1379. *Gammeter's Orthopter: A Beating-wing Flying Machine.* **H. C. Gammeter.** (Scientific American, 97. pp. 253 and 258, Oct. 12, 1907.)—Illustrated.

1380. *Experiments in Flying.* **L. J. Lesh.** (Scientific American, 97. pp. 272 and 274, Oct. 19, 1907.)—An illustrated account of the author's experiments with an aeroplane glider. L. H. W.

1381. *Farman's Aeroplane.* (Automotor Journ. 12. pp. 1527 and 1531–1532, Nov. 2, 1907.)—An account, with photographs, of the aeroplane with which H. Farman has made a (record) flight of 771 metres. L. H. W.

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[1] Electric Automobiles are described in the Section dealing with Electric Traction.

INDUSTRIAL ELECTRO-CHEMISTRY, GENERAL ELECTRICAL ENGINEERING, AND PROPERTIES AND TREATMENT OF MATERIALS.

1382. *Refining of Copper.* **D. Saito.** (Coll. Sci. Engin., Mem. Kyōtō, 1. 3. pp. 195–204, 1906–1907.)—A study of the chemical changes in copper during the dry refining process, as carried out in a reverberatory furnace of 15 tons capacity, using coal as fuel, at the Beshi Copper Works in Japan. The blister copper used for the refining process contains 98·97 per cent. Cu and is raised to 99·82 per cent. Cu by the final refining operation. The author gives details of his methods of testing for oxygen, sulphur, and iron—the three chief impurities—and also presents a diagram showing the results of his analyses of 14 samples taken at intervals from the furnace during the refining treatment. Summarising these results, he states that the greater portion of the impurities are oxidised during the early stages of the furnace process, and that the copper might be tapped at the end of the first "rabbling," or poling, with considerable economy both in fuel and labour costs. J. B. C. K.

1383. *Desulphurising of Iron in Kjellin Furnaces.* **A. Schmid.** (Stahl u. Eisen, 27. pp. 1613–1615, Nov. 6, 1907.)—Doubting that the sulphur of the iron passes into the slag in electric induction furnaces, as is usually assumed, the author conducted special smeltings at Gurtnellen with Kjellin furnaces, charged with 2 or 3 tons of wrought iron, ore, ferro-manganese, and ferro-silicon, adding very little lime and not renewing the flux. In one case 2 tons of iron with 20 kg. of lime contained altogether 2,966 gm. of sulphur, which by smelting was reduced to 280 gm.; yet the slag was free of sulphur, but the smell of SO_2 very noticeable. The lining of the furnace had not absorbed sulphur either. The author suggests that the sulphur is oxidised to SO_2 by the oxygen of the ore, and that this would only be effected by alternating currents, not by direct currents. According to Saconey, Stassano—who smelts the iron by the reflected heat of arcs above the metal—does not really get rid of the sulphur. H. B.

1384. *Electric Induction Steel Furnace of Röchling-Rodenhauser.* **H. Wedding.** (Stahl u. Eisen, 27. pp. 1605–1612, Nov. 6, 1907.)—The author describes the 5-ton furnace, of the Kjellin type, designed by H. Röchling and Rodenhauser for the Thomas iron of the Röchling Eisen-und Stahlwerke at Völklingen, and experiments which he made with a 3·5-ton furnace of the same type. The furnaces give soft or hard iron and steel as desired. The trough is an oval, encircling both the cores of the transformer; in the space between the two cores the trough widens out to a broad hearth. Each core consists of a primary surrounded on the outside by the secondary, which in its turn is surrounded by an air-jacket with copper walls; through this jacket, and through the hollow axis of the core circulates the filtered air-blast. Special electrodes, embedded in the lining and covered with a protective conducting substance, lead the secondary currents which are induced in the iron, also direct to the broader portion of the trough. The general construction is that of a Martin furnace tilting on rollers. The trough is lined with magnesia and 10 per cent. of tar; this compound is dried by packing the

trough with rings of soft iron heated by the current. The furnace is to work with alternating current of 5,000 volts at 15 ∿. The experiments had to be conducted with current at 8,000 volts at 5 ∿; current curves, analyses, and mechanical tests are given. After each heat the furnace is partly discharged, some 800 kg. of iron being left in it, because things are not at once ready for a second charge from the Thomas converters. The first flux applied consists of lime with 6 per cent. of magnesia and some fluorspar; afterwards the magnesia is omitted. The author adds a cost estimate demonstrating that such furnaces would pay for the refining of finished iron; he does not believe that electric smelting of iron can be recommended for other purposes. H. B.

1385. *Fixation of Atmospheric Nitrogen by means of Arc Flames.* **J. Mościcki.** (Elektrotechn. Zeitschr. 28. pp. 1003–1005, Oct. 17; 1032–1035, Oct. 24, and pp. 1055–1058, Oct. 31, 1907.)—The author gives a detailed account of his experiments which he began under Kowalski in 1900. He first tried, in his experimental plant of 100 h.p. at Vevey in 1903, many arcs in parallel, fed with alternating current at 50,000 volts, and 50 ∿. Each arc flame was in series with a Mościcki condenser and an inductance. The arcs were grouped in two halves, between one earthed conductor and two mains joined to the secondary of the transformer. A condenser was inserted between the leads of each half, and a choking coil bridged over the outer mains to compensate for the very considerable phase lag ($\cos \phi = 0{\cdot}2$); this compensation is stated to have been perfect. The furnace was cylindrical and provided with double walls, and a vertical double-wall partition dividing it in two halves. The aluminium electrodes were passed with their porcelain insulations through the walls; plates of mica were pushed over the tips to keep off the radiation from the arcs; the central partition was the other electrode. The air passed up the outer jacket, down between the double partition, and up again through the two rows of 90 arcs. Exaggerated accounts of Birkeland's yields induced the author to give up this complicated arrangement and to experiment with long flames produced in a kind of chimney. Finally, he adopted a rotating arc. The arc flame is produced between two vertical concentric copper electrodes and rotated by magnetic lines of force parallel to the axis, spinning round in the annular space; the electrodes and electromagnets are cooled by water and oil. Using first alternating current, he required an ignition device for the arc which is described. But he now applies direct current, supplied by a compound dynamo at 1,500 volts or more. Only 1 per cent. of the energy is absorbed in the auxiliary apparatus, and 525 kg. of HNO_3 were obtained per kw.-year with the first laboratory furnace of 27 kw. The simple furnace—dimensions not stated—would be suitable for working at higher pressures. The later patents of the author are in the name of the Initiativkomitee zur Herstellung von Stickstoffhaltigen Produkten, Freiburg. H. B.

1386. *Electric Welding Progress.* **Elihu Thomson.** (West. Electn. 41. pp. 245–246, Sept. 28, 1907.)—This article is a summary of the principal applications of the Thomson process. The manageability of the method is shown by the fact that dissimilar metals may be welded, in addition to difficult metals and alloys, such as copper, brass, bronze, and even fusible metals like lead. In welding iron no flux is required, but the use of a flux such as borax enables hard steel to be welded at a comparatively low and safe temperature. The Thomson system is best adapted to repetition work on

a large scale. The applications mentioned include the production of carriage hardware, bicycle parts, metal wheels, wires in rubber tyres, automobile parts, tools, machine parts, wire netting, pipes, tramway rails, rings and bands, gas bottles, crank-shafts, cutlery, chains, &c. The longitudinal seams in pipes and tubes up to 16 in. diam. are welded by rolling the sheet so that the edges meet and passing the skelp between the welding rolls. Tubes so made are uniform in diam. and thickness of walls. By a modification taper tubes may also be formed. Reference is made to the welding of thin sheet metal pieces face to face. [see Abstract No. 1158 (1907)] and to the use of electrically welded wire mesh in reinforced concrete. The tendency in the development of the electric welding process is now towards rendering the operation automatic, on account of the rapidity and uniformity of the results thus obtained. R. J. W.-J.

1387. *Vulcanisation Tests with Plantation Rubber.* **C. Beadle** and **H. P. Stevens.** (Chem. News, 96. pp. 187–188, Oct. 18, 1907.)—On account of criticism of the authors' previous work [see Abstract No. 1018 (1907)] on the ground that their hard-cure Para rubber, having been washed and dried, was more severely treated than the plantation rubber with which they made comparative vulcanisation tests, it is now pointed out that the difference is as nearly as possible an exact imitation of what occurs in the manufacturing processes. Further results are now given, in which hard-cure Para which had been washed and dried by a manufacturer in the ordinary way proved inferior in tensile strength to the Para referred to in the earlier tests, and hence not so good as the plantation rubber, with similar vulcanisation. It is found that the various forms in which plantation rubbers at present reach the manufacturer—sheet, biscuit, block, crepe, &c.—give materially different results on vulcanisation. This is being further investigated. F. R.

1388. *Improved Form of Hot-wire Instrument.* (Elektrotechnik u. Maschinenbau, 25. p. 865, Nov. 3, 1907.)—The sensitiveness of hot-wire ammeters rapidly decreases beyond a certain point, owing to the fact that when the sag reaches a certain limit the ratio of increment of sag to increment of elongation rapidly decreases. This ratio has a maximum value at the minimum of sag. Frequently, however, it is advantageous to have a very open scale at the higher readings, and this result is secured by the Siemens-Schuckertwerke as follows (D. R.-P. 185,207). One end of the hot wire is permanently fixed, while the other is connected to the end of a spring which maintains it in sufficient tension to prevent any appreciable sagging up to a certain value of the current; beyond this value, however, the movable end of the spring is arrested by a detent, so that the slack must be taken up entirely by sag. A very open scale for the higher readings may thereby be obtained. A. H.

1389. *Magnetometric Apparatus for Testing Iron.* **E. Haupt.** (Elektrotechn. Zeitschr. 28. pp. 1069–1071; Discussion, pp. 1071–1072, Oct. 31, 1907. Communication from the Kaiserl. Telegraphen-Versuchsamt.)—The apparatus described by the author was designed primarily for the purpose of testing the magnetic qualities of very small samples, such as the cores and armatures of relays, &c. The movable part of the instrument consists of an astatic system formed by two vertical needles held in a suitable frame which is delicately pivoted. The controlling couple is furnished by

a fine spiral spring. In a vertical plane normal to the plane of the needles are arranged two horizontal solenoids, whose axes are respectively in the planes of the lines joining the upper and lower pairs of poles. The direction of the currents is such that the couples exerted by the solenoids on the astatic system balance each other. This balance is disturbed if the sample to be tested is introduced into one of the solenoids, and the movable system is then brought back to its zero position by means of a torsion head. The angle of torsion is proportional to the intensity of magnetisation. By gradually increasing and then decreasing the current, and noting the corresponding angles of torsion, the magnetic behaviour of the material may be studied. Absolute values are obtained by standardising the instrument by means of a sample of known magnetic qualities. In the *discussion*, **Gumlich** pointed out that the weak point of the apparatus lay in the difficulty of obtaining a reliable standard: even if the magnetic qualities of the material from which the standard is prepared are accurately known, the tooling of the standard sample will alter these qualities to a greater or smaller extent. A. H.

1390. *Temperature Compensation in Instruments of the Induction Type.* (Elektrotechnik u. Maschinenbau, 25. p. 864, Nov. 8, 1907.)—In measuring instruments of the induction type in which gravity or a spring furnishes the controlling couple, a temperature error arises by reason of the weakening of the deflecting torque caused by the increase of resistance of the disc or cylinder acted on by the electromagnets. If copper or aluminium be used in the construction of the disc, the temperature error becomes large; while if a high-resistivity alloy be employed, the temperature error may be made very small, but the deflecting couple is also greatly reduced. In order to meet this difficulty E. Meylan & Co. have patented [D.R.-P. 188,819] an arrangement in which magnetic shunts consisting of nickel steel are used, whose permeability decreases with increase of temperature; instead of such shunts, auxiliary magnets having cores of the same material, and giving rise to a couple which opposes the main deflecting couple, may be used. A. H.

1391. *Constant Speed Apparatus for Measuring Purposes.* (Electrical World, 50. pp. 891–892, Nov. 2, 1907.)—The constant-speed rotary converter recently patented by E. F. Northrup [Abstract No. 1088 (1907)] is now being manufactured by the Leeds and Northrup Co. The output of the converter is 200 watts. The load is connected across the slip-rings in parallel with the 32-c.p. lamp-load circuit controlled by the electrically-driven tuning-fork. This fork is fitted with sliding-weights for coarse adjustment of the frequency, and with a small U-shaped spring placed between the prongs and pressing against them for fine adjustment; the spring may be displaced by the aid of a suitable adjusting screw while the fork is vibrating. The converter is, in addition to its commutator and slip-rings, also fitted with a commutator by means of which a rectified current is obtainable. This is useful in bridge measurements, as an ordinary moving-coil galvanometer may then be used in measuring inductances and capacities. The speed may be relied on to remain constant to 0·02 per cent. Among other uses the apparatus may be employed to drive chronographs with very great precision. A. H.

1392. *Theory of Wurts Lightning Arrester.* **J. Liska.** (Elektrotechnik u. Maschinenbau, 25. pp. 825–827, Oct. 27, 1907. Écl. Électr. 53. pp. 282–284,

Nov. 28, 1907.)—If we neglect the capacity to earth of the cylinders forming the lightning arrester, the potential gradient will have a uniform value over the entire series of gaps. But if the capacity to earth is appreciable, the steepest potential gradient is found to occur at the extreme gaps, which are the first to break down. This may reduce the maximum gradient to such an extent that the discharge does not continue over the central gaps. With a sufficiently high voltage-rise, however, the entire series of gaps is bridged, and the generator voltage starts a series of arcs. The normal voltage being, however, insufficient to maintain the arcs, these go out. The extinction of the arcs may be facilitated by the use of so-called "non-arcing" metal, but this is by no means an essential feature of the operation of the arrester, although commonly believed to be so. The author suggests that since the capacity to earth of the cylinders determines the potential distribution, this distribution may be conveniently adjusted as desired by mounting the cylinders between two earthed metal plates, and varying the distance between the cylinders and plates. A. H.

1393. *Water-jet Lightning Arrester.* (Electrical World, 50. p. 767, Oct. 19, 1907.)—In the type of arrester patented by S. Schneider two horns are provided. One of these is prolonged vertically downwards, and the other is mounted on a water-tap from which issues a jet of water. When the potential of the insulated horn exceeds a certain limit, the jet of water is attracted by the vertical prolongation downwards of the horn, thereby earthing it until the potential is sufficiently reduced. The tap from which the water-jet issues is mounted on a sufficient length of insulating tube through which the water is supplied, so as to avoid a dead earth (U.S. Pat. 866,075). A. H.

1394. *Novel Self-contained Electric Hoist.* (West. Electn. 41. p. 304, Oct. 19, 1907.)—The device, which has been patented by J. L. Pilling, contains a motor, the armature and field of which revolve in opposite directions; the field frame is circular, and its outer surface is grooved to form a double-winding drum. Attached to the latter are the two ends of a single rope which passes down and round two pulleys in the sheave block below, and then up and around another sheave block fixed to the hoist in such a position as to keep it in balance at all loads. The armature and field are contained in an inverted U-frame, and are geared together through pinion and worm gearing, which forms a reliable lock against backward rotation with a suspended load. As the field rotates, it is provided with collector rings, and the field hub carries the armature brush-holders; the controller is attached to the outside fixed frame, and is worked from the floor level by means of two ropes. H. F. H.

REFERENCES.

1395. *Production of Phosphorus in the Electric Furnace.* **G. W. Stose.** (Electrochem. Ind., N.Y. 5. pp. 407–409, Oct., 1907. From a publication of the United States Geological Survey.)—A review of suggested and actual processes.

1396. *Moving-coil Ammeter.* **A. Schortau.** (Elektrotechn. Zeitschr. 28. pp. 971–972, Oct. 3, 1907. Paper read before the Verband. Deutscher Elektrotechniker, Hamburg.)—An illustrated description of a moving-coil instrument whose characteristic feature is an air-gap extending over a considerable portion of the circumference. In general arrangement it resembles the Davies moving-coil instruments [Abstract No. 1691 (1900)]. A. H.

GENERATORS, MOTORS, AND TRANSFORMERS.

1397. *Practicability of 22,000-volt Generators.* (Amer. Inst. Elect. Engin., Proc. 26. pp. 1566–1594, Oct., 1907. Discussion.) [For B. A. Behrend's paper see Abstract No. 918 (1907).]—**C. E. Skinner, W. S. Murray, W. L. Waters,** and **H. G. Stott** deal with the various difficulties connected with the operation of high-voltage generators. One of these is the question of lightning protection. A generator which is in direct connection with the transmission line is much more liable to damage by high-voltage surges than a generator which is supplying step-up transformers. According to **P. H. Thomas**, greater reliability of operation in the case of large high-voltage systems will be secured by maintaining electrically separate the various divisions of the system. This is feasible with step-up transformers, but impossible with generators directly across the lines; as a result, a surge originating in any part of the system may spread and cause breakdowns in several places. **P. Torchio** gives the following table of costs and efficiencies for generators of different voltages:—

Voltage of alternator	2,300	15,000	25,000
Relative cost	100	130	155
Efficiency	96	95·25	94·2

W. S. Murray raises the question of regulation in the case of high-voltage machines, in which the use of a distributed winding is inadmissible. In reply, **Behrend** states that from a large number of tests carried out by him on various types of machines, having from 1 to 6 slots per pole per phase, he has arrived at the conclusion that voltage regulation is equally good in the various cases, armature reaction being less in the generator having fewer slots, and leakage reactance greater. **W. J. Foster** gives the following data relating to some 5,000-kw., 50-∿, 20,000-volt, 100-r.p.m., engine-driven alternators now being installed for the Pacific Light and Power Co., Los Angeles, California. Floor space required, 31 ft. × 6 ft. 9 in.; diam. of stator, 28·5 ft.; diam. of rotor, 25 ft.; radius of gyration, 8·8 ft.; weight of rotor, 186,000 lbs.; weight of stator, 162,000 lbs. The armature coils have stood a test of 40,000 volts for 1 min. The commercial efficiency is 96·5, 96·2, 95·2, 93·5, and 88 at 1·25, 1, 0·75, 0·5, and 0·25 load respectively. He states that 22,000-volt generators, properly rated, offer less difficulty in design and construction than many 6,600-volt machines. **H. F. Parshall** states that in connection with the proposed plant of about 250,000 kw., for the London County Council, a careful consideration of all the circumstances, including the cable system, led to the conclusion that the best result would be obtained by the use of 15,000-volt generators. **E. J. Berg** considers it a mistake to make the generator voltage too low, as with one of the conductors earthed in a Δ-system, the generator windings would be subject to a high potential due to electrostatic induction between the transformer coils. The generator voltage should for this reason be not less than $\frac{1}{6}$ to $\frac{1}{4}$ of the line voltage —corresponding to 16,000—25,000 volts in a 100,000-volt transmission system. **A. H. Pikler** refers to the importance of using a pure sine wave of e.m.f., and to the difficulty which would probably arise in this respect in connection with high-voltage machines. **B. P. Rowe** discusses the question in connection with switch-gear design. The use of high-voltage generators

would simplify the design of the oil-switches in the case of very large units. **G. Semenza** refers to an arrangement adopted in some European plants, which consists in connecting low-voltage generators through circuit-breakers to a set of transformers, without the use of any switches, fuses, or instruments, the generator and its transformers being regarded as a high-voltage generating unit. All the switchboard connections are arranged on the high-voltage side of the transformers. This method combines the advantages of low-voltage generators with those of high-voltage ones, the current capacity to be dealt with by the switchboards being greatly reduced. The only disadvantage is that a fault in a transformer will also throw a generator out of action. A. H.

1398. *5,000-kw. Three-phase Generator.* **H. M. Hobart** and **F. Punga.** (Elektrische Kraftbetr. u. Bahnen, 5. pp. 541–548, Oct. 4; 567–578, Oct. 14; 588–593, Oct. 24, and pp. 611–614, Nov. 4, 1907. Écl. Électr. 53. pp. 269–277, Nov. 23; 311–318, Nov. 30; 383–386, Dec. 14, *et seq.*, 1907.)—The authors give a detailed illustrated description of, and an account of tests carried out on, a 5,000-kw. three-phase generator—one of several recently constructed by the Siemens-Schuckertwerke. The machine was required to give the specified output at 4,000 volts, a power-factor of 0·99, and a frequency of 50. The stator core has an external diam. of 443 cm., an internal diam. of 375 cm., a gross length of 51 cm., and a net length of iron = 38·6 cm., there being 9 ventilating ducts, each 0·9 cm. wide. The total number of slots is 210, each being 5·6 × 2·34 cm. The armature winding shows an interesting departure from the usual type. There are 3½ slots and 7 conductors per pole per phase, there being 2 conductors per slot. Thus while in three consecutive slots there are conductors belonging to one phase only, the fourth slot contains 2 conductors belonging to different phases. The winding is an irregular wave-winding. Each conductor is 1·8 × 1·8 cm. The conductors at the bottom of the slots are solid bars of copper, while those at the top consist of 9 strips, each 1·8 × 0·2 cm. The object of laminating the top conductors is to reduce the eddy-current loss; this loss would not be reduced by such lamination if the joints were close to the ends of the core; but on account of the considerable length of the projecting ends of the conductors, the length of the eddy-current paths will be increased in the ratio of the embedded portion to the total length of conductor, and the loss will be reduced in the same ratio. In order to prevent mechanical damage to the projecting ends of the conductors by a short-circuit, the joints between the conductors are firmly clamped between an inwardly projecting lip of the yoke-ring and an inner supporting ring. The magnet wheel has an overall diam. of 373·4 cm.; each pole has a radial length of 32·05 cm., and the diam. of its circular cross-section = 37 cm. The poles are fitted with laminated pole-shoes. The surfaces of the pole-shoes are well rounded, the minimum length of gap at the middle being 0·8 cm. The ratio of pole-arc to pole-pitch is 0·667. Each field coil consists of 68 turns of 3·5 × 0·4 cm. copper strip. The authors apply the method explained in Abstract No. 1060 (1904) to predetermine the performance of the machine [see also Abstract No. 52 (1907)], and compare the theoretical results with the experimental ones. The losses occurring in the generator were determined by driving it by means of two continuous-current motors. The excitation was varied, and the power taken by the motors determined for each value of the generator e.m.f. The curve of core losses so obtained was found to be very nearly parabolic, the losses increasing as the square of the open-circuit voltage. This result is confirmed by measure-

ments on other machines ; the authors ascribe it to the fact that as saturation of the teeth sets in, the eddy-current loss in the armature conductors rapidly increases. The armature core loss (including also the eddy-current loss in the armature copper) may be calculated by means of the formula $k\left(\frac{B}{1000}\right)^2 \times w$, where B = induction in core, w = weight of core, in kg. ; and k is a constant lying between 0·085 and 0·1 for a frequency of 50 and ordinary (not alloyed) core stampings 0·5 mm. thick. In the case of the generator under consideration, k had a value of 0·112 ; this the authors ascribe to the very large cross-section of the armature conductors. The following table gives an analysis of the losses (expressed in kw.) and the efficiency at a voltage of 4,000, full load current (780 amps.), and power-factors of 1·0 and 0·8 :—

	Iron Losses.	Copper Loss (excluding eddies).	Eddy-currents in Copper.	Excitation Loss.	Friction and Windage.	Total Losses.	Useful Power.	Efficiency.
Power-factor = 1·0	93	19·5	23·6	7·0	52	195·1	5,000	96·2 per cent.
„ „ = 0·8	93	19·5	23·6	12·5	52	200·6	4,000	95·2 „

Heat tests showed the following maximum temperature-rises as measured by thermometer : Stator core, 87° C. ; armature copper, 87° C. ; field copper, 25° C. Experiments were also carried out with the object of determining the effect of forced ventilation, the rotor being fitted with ventilating vanes, and it was found possible materially to reduce the temperature-rise by this method. The wave-form of the generator was found to deviate but little from the pure sine wave. The generator was subjected to a sudden short-circuit test, which it stood satisfactorily. The concluding portion of the paper contains an account of experimental determinations of the armature reactance under various conditions. A. H.

1399. *Distribution and Breadth Coefficients of Alternators.* **N. Stahl.** (Electrical World, 50. pp. 921–923, Nov. 9, 1907.)—A mathematical investigation of the fundamental formula for the e.m.f. in alternator armature windings. The author introduces two coefficients into the e.m.f. equation: (1) a distribution coefficient which takes account of the distribution of the coil or the number of slots per pole per phase, and (2) a breadth coefficient taking account of the mean pitch of the coil relative to the pole pitch. Tables are given for the values of these two coefficients derived from the formulæ obtained, for single-, two-, and three-phase windings. A. G. E.

1400. *Improved Dynamo for Arc Welding.* (Elektrische Kraftbetr. u. Bahnen, 5. pp. 593–594, Oct. 24, 1907.)—One of the principal conditions in arc welding is that the load shall be constant. This is difficult to obtain, owing to the varying length of the arc and the liability of the dynamo to be short-circuited. A regulating switch and resistance are normally, therefore, required to prevent damage to the generator, and a certain amount of power is thus wasted. An improved direct-current dynamo has been designed by the A.E.-G. of Berlin, type REG., which renders the use of a regulating switch and resistance unnecessary, and produces a steadier and more intense arc than when an ordinary type of dynamo is employed. The e.m.f. varies, within certain limits, inversely as the strength of the current, so that although the external resistance may vary considerably from the normal value (up to the proportion of 1 : 6), the output is not perceptibly altered. When completel short-circuited the current reaches a value about 60–70 per cent. above

the normal, and the machine will withstand this for a considerable time without injurious heating or sparking. The dynamo is self-excited and series-wound, and runs sparklessly at all loads without shifting of the brushes, which are of carbon. A magnet regulator switch may be used to reduce the strength of the current for small work. R. J. W.-J.

1401. *Commutating Pole Machines.* A. **Rothert.** (Elektrotechn. Zeitschr. 28. pp. 1108–1109, Nov. 14, 1907.)—The author distinguishes two cases—that in which merely a slight improvement in commutation is desired, and the other in which commutation without the aid of interpoles would be practically out of the question. When dealing with machines of the first type no radical departure from the ordinary design is necessary, and various simplifications may be introduced, such as the use of only one or two commutating poles and a shortening of the pole in a direction parallel to the shaft. In cases where the number of commutating poles is less than the number of main poles, the machine should be fitted with two brush sets only, as otherwise there will be coils which are not influenced by the interpoles. If, however, the commutation problem is a difficult one, it is best to re-design the entire machine, and in this connection the author recommends the observance of the following rules. The pitch of the armature winding should be equal to the pole-pitch, and the number of slots in the armature core should equal the number of commutator segments. It is advisable to reduce the pole-arc of the main poles, and to increase that of the interpoles. There should be as many interpoles as there are main poles. The length of the commutating pole-shoe in a direction parallel to the shaft should be equal to the length of the armature core. A. H.

1402. *Oerlikon Single-phase Series Motor.* (Elektrotechn. Zeitschr. 28. pp. 1075–1077, Nov. 7, 1907.)—This type of motor is provided with a compensating winding, and a commutating pole winding. The former is short-circuited on itself, while the latter may be arranged in four different ways. In the first method the winding is in series with the armature, and is shunted by a non-inductive resistance. In the second, it is connected in series with a reactance, and then as a shunt across the armature. In the third, an auto-transformer is connected across the armature, and the commutating pole winding is connected between the middle point of the auto-transformer and one of the brushes. In the fourth, we have a combination of the first and third methods : the commutating pole winding is in series with the armature, but the end not in direct connection with the armature is also joined to an intermediate point of an auto-transformer which is across the armature. An illustrated description is given of a 60-h.p. motor of this type, and its characteristics given when operated with single-phase and continuous-current. The stator has uniformly distributed slots, and the commutating pole winding is so arranged as to form a continuation of the compensating winding. A. H.

1403. *Theory of the Rotary Converter.* **T. Ôtake.** (Coll. Sci. Engin., Mem. Kyōtō, 1. 3. pp. 228–253, 1906–1907.)—In the ordinary theory it is assumed that the direct and alternating current sides are independent of each other. The author works out a more complete theory which obviates the necessity of making this assumption, and arrives at the following conclusions. (1) The direct current is not in general a true direct current, but a pulsating one. (2) If m denote the number of phases, the period of pulsation is m times that

of the applied voltage. (3) As in a synchronous motor, the effect of armature reaction is always to oppose the change in the excitation. (4) When charging a battery the fluctuation is larger than when feeding an inductive circuit. (5) The current in the alternating leads is different from that in the corresponding case of a synchronous motor. It is equal to the current for a synchronous motor together with a pulsating current which has a period equal to one revolution of the armature. (6) The mathematical equation that has to be satisfied in order that the converter may be looked upon as a combination of a synchronous motor and direct-current generator, is found.
A. R.

1404. *Converter with Variable Transformation Ratio.* (Electrical World, 50. pp. 892–893, Nov. 2, 1907.)—The ratio of the alternating- to the continuous-current voltage in a converter depends on the ratio of the r.m.s. to the maximum value of the e.m.f. By varying the wave-form, the ratio of the two voltages may be varied. This is the principle underlying the method employed by the Electric Storage Battery Co., of Philadelphia, Pa. The wave-form is controlled by varying the flux distribution. For this purpose the field poles are split, and are provided with special windings controlled by a carbon regulator. In this way the battery connected across the converter terminals may be made to charge and discharge in response to load fluctuations on the alternating-current side without the use of a booster. A. H.

1405. *Motor-generators* v. *Rotary Converters.* (Amer. Inst. Elect. Engin., Proc. 26. pp. 1528–1565, Oct., 1907. Discussion.) [For P.M. Lincoln's paper see Abstract No. 403 (1907).]—**A. H. Armstrong** considers the question to be one of voltage regulation; the requirements of a railway system being best met, as to first cost and efficiency of operation, by the adoption of the rotary converter, while for a lighting system the better voltage regulation obtainable with the motor-generator renders this latter preferable in cases where the alternating-current distribution system supplies a violently fluctuating load. **W. L. Waters** points out that the converter is much more liable to flash over than the motor-generator. As regards first cost, a good deal depends on the circumstances of each case. Thus, in the case of a 1,500-kw., 275-volt, 25-∿ machine, the converter would run at about 187 r.p.m., as a smaller number of poles than 16 could not very well be used; while the motor-generator, by the use of commutating poles, could be designed to run satisfactorily at 800 r.p.m., or even more. In this case there would be practically no difference between the cost of the two machines. Speaking generally, the motor-generator seems, from an operating standpoint, preferable to the rotary converter in most respects, except where cheap medium-sized units are in question. **R. D. Mershon** lays stress on the fact that the operation of the motor-generator is largely independent of the line voltage, and that hence this machine is particularly well adapted for use at the end of a long transmission line subject to considerable voltage fluctuations. **P. Torchio** draws attention to the liability of converters to fall out of step when the resistance drop along the transmission line exceeds a certain limit, generally 10 per cent.; thus any momentary heavy short-circuit at the end of a long transmission line would be fatal to the continuity of the service if converters were used. **J. R. C. Armstrong** describes the following method of starting a rotary converter from the continuous-current side, which is now largely used in New York with very satisfactory results. The converter is first run up to full speed from the continuous-current side; the circuit-

breaker on this side is then tripped, the supply of continuous current being thereby cut off. Immediately afterwards a large resistance is introduced into the field circuit, and then the oil-switch on the alternating-current side is closed. Finally, the field resistance is cut out and the machine is now ready for service. This method of starting is very rapid, requiring not more than a minute even in the case of units of large size; and it is much cheaper as regards first cost than some of the other methods in use. **A. H. Babcock** states that experience on long lines in the West has shown 60-∿ converters to be troublesome, and that 25 ∿ may be regarded as the limit of satisfactory operation in such cases. This opinion is also shared by **E. P. Burch.** **C. E. Gifford** points out that while in the case of the motor-generator surges on the transmission line cannot affect the insulation of apparatus on the continuous-current side, breakdowns of insulation from this cause have occurred in the case of converters. **F. Osgood** gives an interesting account of his experiences with 60-∿ converters. When first installed, they proved exceedingly troublesome; but when the voltage regulation of the transmission line was greatly improved most of the difficulties formerly experienced disappeared, and the converters are now found to be very reliable. He regards the whole secret of the successful operation of converters as consisting in careful voltage regulation on the alternating-current side. **L. Schüler** recommends converters for 25-∿ railway or other motor circuits, and motor-generators for all 60-∿ circuits, and for all lighting circuits. **M. Walker** states that a well-designed 50-∿ converter can take very heavy overloads without commutation or heating troubles, and is for this reason to be preferred to a motor-generator where there are violent fluctuations of load. [see also Abstract No. 550 (1907)]. A. H.

REFERENCES.

1406. *Upkeep Charges on Large Electric Generating Sets.* **H. R. J. Burstall** and **J. S. Highfield.** (Inst. Civ. Engin., Conference vol. (Sect. 7) pp. 33–36; Discussion, pp. 37–42, 1907. Electrician, 59. pp. 386–387; Discussion, p. 387, June 21, 1907. Elect. Engineering, 1. pp. 1087–1088; Discussion, p. 1088, June 27, 1907.)

1407. *Theory of Alternators.* **H. Zipp.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1749–1754, Nov. 2, 1907.)—The author's method is based on the consideration of the field diagram, consisting of a right-angled triangle, whose hypotenuse represents the impressed field, and whose sides correspond to the resultant and armature fields respectively. The behaviour of the alternator under various load conditions is deduced from this diagram. A. H.

1408. *Water Resistances for Testing Large Alternators.* **C. Richter.** (Elektrotechnik u. Maschinenbau, 25. pp. 889–896, Nov. 17, 1907.)—The author considers in detail the design of such resistances, and gives useful tables intended to facilitate the calculation of the dimensions of the containing vessel, electrodes, &c. A. H.

1409. *Theory of Commutation.* **C. L. R. E. Menges, E. Arnold, R. Rüdenberg.** (Elektrotechn. Zeitschr. 28. pp. 1058–1063 and pp. 1072–1074, Oct. 31, 1907.)—Menges criticises the commonly accepted theory of commutation, and regards the introduction of the notion of self-inductance as giving rise to confusion. Arnold emphasises the fact that it is only the leakage self-inductance that has to be considered. Rüdenberg also differs from Menges, and establishes the differential equations relating to commutation. A. H.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING

ELECTRICAL DISTRIBUTION.

1410. *Constants of Cables and Magnetic Conductors.* **E. J. Berg.** (Amer. Inst. Elect. Engin., Proc. 26. pp. 1491–1504, Oct., 1907.) The author supplements his former paper on line constants [Abstract No. 1809 (1907)] by working out approximate formulæ for the self-inductance and capacity of two parallel cylindrical conductors. He regards 25,000 volts between conductors as the present limit of voltage for cables. Formulæ are given for the self-inductance and capacity of concentric cables. The effects of the currents in the lead sheathing of single-core cables on their effective resistance and reactance when the sheathing is either earthed or insulated, are considered. The possibility of utilising iron as an electrical conductor when the price of copper is abnormally high is next discussed, and it is pointed out that the reactance of iron cables is not, as a rule, prohibitive, their effective resistance being of greater importance; this may be greatly reduced in the case of large conductors by employing a form of cross-section which gives a large perimeter. A. H.

1411. *Regulation of the Pressure at the End of a Three-phase Line.* **E. Wattelet.** (Écl. Électr. 53. pp. 109–115, Oct. 26, 1907.)—In order to maintain the pressures at the terminals of the feeders of an electric network approximately constant, automatic regulating appliances can be used at the generating station. Resistances are put in series with the feeders, and as the current increases the p.d. at the terminals of these resistances actuates a suitable compensating transformer, which raises the p.d. of the feeder. This method is applied to the case of a three-phase transmission line when the load is balanced and the transmission wires are arranged symmetrically. A. R.

1412. *Use of Time-limit Relays.* **M. C. Rypinski.** (Electrical World, 50. pp. 888–889, Nov. 2, 1907.)—After briefly explaining the use of time-limit relays, the author recommends the following arrangements. Generators should either be protected by a reverse-power relay with a time-limit feature, or else have no automatic protective device at all. Feeders should be provided with overload inverse-time-element relays at the power station, and with reverse-power i.t.e. relays at the substation. Synchronous converters should be protected by an overload i.t.e. relay on the high-voltage side of the step-down transformers, and by a reverse-power i.t.e. relay on the continuous-current side. A. H.

1413. *Application of the Storage Battery to Lighting, Power and Railway Service.* **J. M. S. Waring.** (West. Soc. Engin., Journ. 12. pp. 473–487; Discussion, pp. 488–494, Aug., 1907. Mech. Eng. 20. pp. 656–658, Nov. 9, 1907. Abstract.)—Part I. deals with the characteristics of batteries, and then goes into the question of automatic and hand regulation. The type of reversible booster described has its field winding connected between one of the cells and the middle point of a double carbon resistance permanently

joined across several of the same cells; the carbon resistance is controlled by a solenoid in such a way that variations in the generator current produce variations or reversals in the booster field which tend to keep the generator load constant at the expense of the battery. In Part II., the advantages of a battery in improving the load-factor, and relieving the generating plant of overload, are pointed out. In the *discussion*, the **Author** described the benefits which had followed the introduction of a battery at the power-houses of two large steel works, using both alternating and continuous current. In reply to **F. M. Davis**, he also stated that it was only advisable to put extra plates in the initial equipment to save expense later on, provided such extra plates would be required within about the first year; otherwise, it was more economical to add the plates afterwards. **Junkersfeld** and **Roper** pointed out that the American practice of using end-cell regulation on lighting loads was preferred to the English practice of the reversible booster on the score of economy and greater reliability. **Beck** stated that the life of plates varied between four and ten or more years. H. F. H.

1414. *The Thury Direct-current Transmission System.* **D. Kos.** (Electrical World, 50. pp. 804–809, Oct. 26, 1907. Elect. Rev. 61. pp. 867–868, Nov. 22, 1907. Abstract.)—The author describes the Thury system and discusses the theoretical principles on which it is based. He considers that the superiority of the Thury system applies only to those cases where all the power is transmitted in bulk to the extreme end of the line. The necessity of motor regulation is a great drawback to this system. The author a few years ago visited one of the older and smaller Thury plants at Batoum, Russia, and was surprised to find the plant running satisfactorily, although all the regulating apparatus in both the generating and receiving stations was disconnected, as the operators did not know how to repair it. In most of the large Thury systems the regulator seems indispensable, as the secondary systems are three-phase for motor and lamp service. When the motor, however, is used to drive a generator employed for battery charging, the regulator is unnecessary. Probably also for any direct-current system with a battery in parallel the regulator can be dispensed with. A. R.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

1415. *Montreal Track Reconstruction with Steel Ties.* (Street Rly. Journ. 30. p. 845, Sept. 7, 1907.)—Diagrams are given in the original article, showing the type of track construction with two types of paving which is being used in Montreal to replace 70-lb. grooved rails with 90-lb T-rails and continuous joints on 75 per cent. of its city track. Steel ties are laid 6-ft. centres in an 8-in. concrete foundation with one tie rod between each pair of ties. The concrete is separated from the paving blocks by a ½-in. layer of sand. The cost is about $25,000 per mile. C. E. A.

1416. *Gas-power Central Station of Duquesne Light Co.* **N. C. MacPherson.** (Eng. Record, 56. pp. 460–462; Discussion, p. 462, Oct. 26, 1907. Paper read before the Pittsburg branch of the Amer. Inst. Elect. Engin.)—The station is designed for 4 units, but at present has two generating units installed and working on an excellent load-factor. Each unit consists of a 8-cylinder vertical single-acting gas engine with cylinders 18 in. diam., 22 in.

stroke, 200 r.p.m. direct connected through a flexible spring coupling to a 180-kw. engine-type, 60-cycle, alternator. The engines use natural gas, and have compressed-air reservoirs at 150 lbs. pressure for starting. The direct-current excitation for the main generators is provided by two 110-volt compound-wound dynamos which are connected directly to induction motors, which, in turn, are fed directly from either set of main switchboard bus-bars. These motor-generators have also pulleys for a belt drive from either of the main engines, through friction clutches. For ignition purposes a 110-volt shunt wound generator and a set of 4-volt storage batteries are provided—and on the engines there is a device for changing igniters while running. By means of ingenious adjustments of governor and a pair of springs at the mixing valve working against the governor spring, the amount of load put upon any unit is under thorough control and there is no difficulty with parallel operation and regulation throughout the plant. The author then discusses the cost of power with natural gas at 25 and at 15 cents per 1,000 cub. ft., and the facility given by gas engines for splitting up the station capacity and reducing in this way losses by partial disablement of any part of the plant. In *discussing* the paper, **J. R. Bibbins** enlarged on this question of relative spare capacity and favoured a number of small units with gas engines. Relative heat consumption and cost of spare capacity were both in favour of that plan. By the use of a storage battery the generator load may be held practically constant, while the entire fluctuating load is taken up by the battery, and in this way the disadvantage of the gas engine on rapidly fluctuating loads can be overcome. This is accomplished by a load regulator, an instrument of the relay type, installed on the switchboard and operating in connection with the booster. In a recent test with this instrument the external load was instantly varied through a range equivalent to 300 per cent. of the generator capacity, but the generator kept within a few per cent. of its rating irrespective of the suddenness or violence of the fluctuations. [See also Abstract No. 1182 (1907).] F. J. R.

1417. *Suction-gas Generating Plant at Neisse.* **Paufler.** (Elektrische Kraftbetr. u. Bahnen, 5. pp. 614–616, Nov. 4, 1907.)—This plant consists of 2 gas-producers, each of 250 h.p., and of 2 generating sets, one of 125 h.p. and the other of 250 h.p. The gas-producers were supplied by J. Pintsch, of Berlin, and the gas engines by Körting, of Hanover. The smaller engine has a single cylinder, the larger one two cylinders; the normal speed is 150 r.p.m., the speed fluctuation being $\frac{1}{80}$. The fuel consumption at full load is somewhat less than $\frac{1}{2}$ kg. of coke per h.p.-hour, and the cooling-water consumption is 40 litres per h.p.-hour. A secondary battery having a capacity of 788 amp.-hours is provided. A. H.

1418. *Use of Peat in connection with Large Gas Engines.* (Elektrotechn. Zeitschr. 28. pp. 1077–1080, Nov. 7, 1907.)—The plant described is in use at Riesa on the Elbe, and consists of two 800-h.p. double-acting Deutz gas engines and two 700-h.p. tandem gas engines by the Maschinenfabrik Augsburg-Nürnberg. The engines are direct-coupled to continuous-current generators. The gas-producer plant was supplied by the A.-G. Köln-Deutz. The 700-h.p. engines have a cylinder bore of 700 mm., a stroke of 800 mm., and run at 180 r.p.m. The gas obtained from the peat briquettes had a calorific value of about 1,100 kg.-cals. per m.^{3}, and the mean rate of consumption was 8 m.^{3} per kw.-hour. The cost of the fuel was found to be only 0·855 pf. (=0·102 penny) per kw.-hour. A. H.

1419. *Vienna-Baden Single-phase Railway.* L. Kadrnozka. (Elektrotechnik u. Maschinenbau, 25. pp. 803–808, Oct. 20; 827–831, Oct. 27, and pp. 872–877, Nov. 10, 1907. Elect. Engineering, 2. pp. 929–934, Dec. 12, 1907.)—The total length of this railway is 29·8 km.; 9·4 km. of it are supplied with continuous current from the Vienna electricity works, and the remaining 20·4 km. receive single-phase current from a special generating station near Baden. The trolley-wire voltage is in each case 550. The steepest gradient is about 27·5 per cent. The single-phase and continuous-current overhead conductors are separated from each other by two insulators spaced 18 m. apart, the wire between them being permanently insulated. The overhead equipment is of the standard type for ordinary trolley lines, but the poles also carry the high-voltage wires supplying the step-down transformer substations, of which there are six, spaced about 3·5 km. apart. The transmission voltage is 10,000. In order to secure efficient earthing of the high-voltage conductors in case of a break, each of these conductors is at the insulator surrounded by a nearly closed circle of galvanised iron wire. Where the high-voltage line crosses public roads or streets, it is completely surrounded by a protecting network of wire, and in some cases by a rigid lattice-work of light construction. At the generating station near Baden there are two single-phase alternators, each having an output of 200 kv.a. at 10,000 volts and a frequency of 15. In addition to these, there are two continuous-current generating sets of 165 and 90 kw. capacity, and a secondary battery. These are coupled in parallel with the single-phase sets through two flywheel motor-generators, which are intended to equalise the load on the generating plant, the governors of the engines being so adjusted as to give a drop of about 14 per cent. in the speed from no load to full load. The exciting current is supplied by a 36-kw. converter giving 110 volts on the continuous-current side. Each motor car is mounted on two radial trucks, and is equipped with four 6-pole 40-h.p (one hour's rating) series motors. A starting transformer is provided, by means of which a voltage of 630 is impressed at starting on the four motors connected in series; the next step consists in a parallel connection of the two series groups of motors, and in a reduction of the impressed voltage to 400 (or 200 per motor). Further increase of speed is then obtained by raising the impressed voltage to 600. The motors are said to run quite sparklessly. Owing to local conditions, it was not found economical to use electric traction for the heavy goods trains, which are still hauled by steam locomotives. [See also Abstract No. 315 (1907).] A. H.

1420. *The Pacific Traction Company, Tacoma, Washington.* (Street Rly. Journ. 30. pp. 340–341, Sept. 7, 1907.)—The constructed main line from Tacoma to Lake City is 12½ miles long; a 4-mile branch to Steilacoom, a suburb of Tacoma, and a 1½-mile branch to South Tacoma bring the total constructed mileage up to 18. The company is now engaged in buying right-of-way for a 35-mile extension to Olympia, the State capital. In the streets the track follows the established grades, some of which are as heavy as 6 per cent. The track construction through the paved district is worthy of note. No ties are used. The 7-in., 70-lb., 60-ft. rails are laid directly on top of a 10-in. by 14-in. continuous concrete stringer. The concrete mixture is 1 : 3 : 5, cement, sand, and clean beach gravel respectively. Every 10 ft. a ⅝-in. rod is used. The tops of the stringers are laid about ¼ in. below grade for base of rail as given by the profile; then the track is laid and the rails brought up to grade with light shims; a rich grout of 1 to 1 cement and sand is then poured in between the rail and stringer and around the base of the rail.

The whole is finally surrounded with 6-in. concrete paving and allowed to set. The ball of the rail is faced on both sides with vitrified brick; on the outside the bricks are laid parallel to the rail, on the inside they are set at right angles to it with one corner chipped for the flangeway. Beyond the city the track is standard, light construction, using 60-lb. steel rails, not braced on curves. C. E. A.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

1421. *Improvements in Electric Railway Plant.* (Elektrotechnik u. Maschinenbau, 25. pp. 818–821, Oct. 20, and pp. 840–842, Oct. 27, 1907.)—A review of the more important inventions recently patented in connection with electric railway work. K. v. Kandó, of Budapest, has devised the following flexible suspension for trolley wires at curves. The wire is attached to the bottom end of a short vertical link whose top end and middle point are connected to a tie-rod and strut respectively, the tie and strut being hinged in a bracket fixed to the side of the pole (D.R.-P. 188,152). The Siemens-Schuckert Works propose reducing stray earth currents due to the rail return by using a supplementary conductor maintained below the potential of the rails, and connected to the rails at suitable intervals *through resistances*, the values of the resistances decreasing with increasing distance from the power station (D.R.-P. 184,660). The A.E.-G. has devised the following arrangement for reducing the voltage drop along the return of alternating current railways. A number of concentric or two-core feeders are used; one of the conductors of each feeder is connected to a section of the trolley wire through one winding of a transformer having a ratio of transformation of unity; while the other conductor is, through the remaining winding of the transformer, connected to the rails (D.R.-P. 179,519). In another arrangement patented by the same firm, a concentric or two-core main runs parallel with the track, the conductors of this main being at suitable points connected to the overhead wire and the rails respectively (D.R.-P. 186,112). A. H.

1422. *Steam* versus *Electric Locomotives.* **M. Toltz.** (Street Rly. Journ. 30. pp. 453–456; Discussion, pp. 456–458, Sept. 28, 1907. Abstract of paper read before the New York Railroad Club, Sept. 20, 1907.)—The paper consists of a detailed discussion of items pertaining to steam locomotives, viz., repairs and renewals of locomotives, engines, and round-house men, fuel for locomotives and water supply for locomotives. The author endeavours to show that the steam locomotive, properly improved, is far more economical than the electric locomotive, even taking it for granted that a kw.-hour of electrical power could be furnished at the low figure of 0·6 cent at the bus-bars and at 0·8 cent effective for traction as assumed by Stillwell and Putnam [see Abstract No. 417 (1907)], who further state that 1 h.p. effective for traction will cost therefore 0·6 cent, of which 0·35 cent is for fuel when coal of 14,000 B.Th.U. per lb. costs $3 per ton of 2,240 lbs., and 0·25 cent is for other supplies, labour, and maintenance equipment. It is found from the returns of the Interstate Commerce Commission of 1904 that the average cost of fuel per draw-bar h.p.-hour is 0·6 cent, compared with the estimated cost of fuel of 0·35 cent as above mentioned when assuming the railroads are operated electrically. The former figure agrees with practice on the average steam locomotive, but the author states that most of the locomotives in

[1] Non-electrical Automobiles are described in the Section dealing with Steam and Gas Engines.

service were built over fifteen years ago. The reasoning for comparison should therefore be made upon the basis of the latest type of locomotives, and therefore the writer refers to the locomotive tests made during the St. Louis Exposition, which have established the fact that the coal consumption per draw-bar h.p.-hour was considerably less than 2¼ lbs. Each locomotive has one most economical speed limit, or, in other words, on a given grade at a certain speed with a defined maximum load the locomotive will turn out the most work at the lowest cost. For further explanation the writer submits three graphostatic diagrams showing various characteristics of three different locomotives. These diagrams give the coal consumption per draw-bar h.p.-hour at different speeds, the train-tons on different grades, and the different draw-bar pulls in lbs. and cost data. From these diagrams it can readily be seen that each locomotive does the most economical work at certain speed. The author then discusses economies effected by high superheat and improvements in boilers and feed-water apparatus. In making statements as to saving in the items of (1) repairs and renewals of locomotives; (2) engine and round-house men; (3) fuel for locomotives; (4) water supply for locomotives, the following figures are arrived at: the saving in coal can be figured at 20 per cent. by superheating, at 20 per cent. by feed-water heating, and at 5 per cent. by perfect combustion—an aggregate of 39·2 per cent.; the saving in locomotive repairs, items (1) and (2), 30 per cent.; the saving in water supply for locomotives, 30 per cent. The total saving that may be effected on the aggregate cost of operation of all the railways in the United States which in 1905 amounted to 1,400 million dollars, is shown in the following table, both for the author's estimates on the basis of modern locomotives, and Stillwell and Putnam's estimates for electrical operation.

	Total Estimates for Modern Steam Locomotive.		Stillwell and Putnam Estimates for Electrical Operation.	
	Per Cent.	Annual saving in Millions of Dollars.	Per Cent.	Annual saving in Millions of Dollars.
Saving in item (1)	30	34·50	70	80·50
„ „ (2)	30	29·15	50	64·86
„ „ (3)	39·2	35·46	50	78·25
„ „ (4)	30	2·75	100	9·15
Saving in coal for modern epuipment..................	42·2	66·04	—	—
Total saving per year in millions of dollars	—	167·90	—	232·76

In the *discussion*, **W. McClellan** said that there were other factors to be considered besides the financial ones, such as multiple-unit operation, cleanliness, desirability of a subway service on trunk lines through large cities, the independence of weather conditions, &c. **N. W. Storer** said that in the steam locomotive the max. speed is fixed by the boiler capacity and the economical rate of expansion in the cylinders, but in the electric locomotive with gearless motors a certain tractive effort can be had at any speeds up to 70 m.p.h. with economical voltage regulation. **J. E. Muhlfeld**

gave figures for the costs on the Baltimore and Ohio railroad which show that, compared on the basis of the same tractive effort, the average cost was \$84 for the electric and \$41 for the steam locomotive. The original cost of the different locomotives made on the basis of total working weight is as follows: Passenger electric, 20 c. per lb.; freight electric, 12 c.; Mallett, 9 c.; Pacific, 8 c.; and Consolidation, 8 c. **L. B. Stillwell** referred to the figures given in the author's paper relative to the possible saving of 1·65 lbs. of coal per draw-bar h.p. by using different auxiliaries. Such a large saving seemed rather strange to him in view of the fact that inventors have been trying for years to reduce the coal consumption per h.p. in large central stations. **A. H. Armstrong** said that the electric locomotive recognised no such thing as a ruling grade, and this makes it available for severe grades where the traffic has been hitherto limited by the conditions inherent to steam railroad operation. A saving of 20 per cent. in the cost of fuel was a very small item compared to the benefits of doubling the capacity of the line. A. G. E.

1423. *The Action between Wheel and Rail.* **H. R. A. Mallock.** (Inst. Civ. Engin., Conference vol. (Sect. 1), pp. 44–47; Discussion, pp. 48–60, 1907. Electrician, 59. pp. 398–399; Discussion, p. 399, June 21, 1907. Engineering, 83. p. 867; Discussion, p. 887, June 28, 1907.)—The author discusses theoretically the wear due to the mutual action between the rails and wheels, and comes to the conclusion that the deformation of the rail at the point of contact with the wheel tread is generally, with present loads, beyond the elastic limit, owing to the narrowness of the tread and the small diameter of the wheels. Increase of either of these factors would obviate this permanent deformation. L. H. W.

1424. *Long Wheel-base Trucks.* **R. L. Acland.** (Elect. Engin. 40. pp. 440–443; Discussion, p. 443, Sept. 27, 1907. Paper read before the Municipal Tramways Assoc. Electrician, 59. pp. 959–960; Discussion, pp. 960–961, Sept. 27, 1907. Tram. Rly. World, 22. pp. 301–303; Discussion, pp. 303–305, Oct. 3, 1907.)—The author considers at length the relative merits of the standard single-truck double bogie cars, and of long wheel-base trucks, and gives the experience of several Continental managers with regard to the latter. It may be summarised as follows: For long-bodied cars the double bogie type has been found too heavy, and both first cost and maintenance too high. Cars with two single-axle swivel trucks have been tried, and while suitable for curves are most unsuitable for straight track, owing to the tendency of the axles to remain out of the square, and the consequent excessive wear on the flanges. Continental tracks have now settled down to the single four-wheel truck with a practically rigid wheel-base of from 9 to 12 ft., having a clearance between the axle-box and horn cheek varying from 2 to 12 mm., the axle being maintained in a central position with straight track by link suspension of various designs, two of which are given in the paper. The author's own experience of three years' work with this type of truck at Chesterfield, has demonstrated that a car mounted on a long wheel-base gives the most comfortable riding, owing to the great reduction of pitching and side oscillation; the body is also held in line, being supported practically throughout its length, and can in consequence be of lighter construction. The strain on body, truck and track when running through points or round curves is largely reduced, and no cases of derailing have occurred on this system, unless through an obstruction on the track, and not a single axle has been broken. C. E. A.

1425. *Water-power in Chile.* (Electrician, 60. pp. 92–95, Nov. 1, 1907.)—A list of existing developments is given, followed by a report of A. E. Salazar on the application of electric power to the Arica-Tacora Railway. The report recommends single-phase working, and criticises proposals which have been put forward for the purpose, concluding, however, that a material saving would be effected by the use of electricity instead of steam. The railway section to be electrically operated is 162 km. in length, and presents great constructional difficulties, traversing a mountainous region with gradients of 6 per cent. A. H. A.

1426. *Working Costs with Surface Contact Traction Systems at Lincoln and Wolverhampton.* (Elect. Engineering, 2. pp. 163–164, Aug. 1, and p. 325, Aug. 29, 1907.)—The first article analyses the results of a year's working at Lincoln with the "G.B." system, to March 31, 1907; the second, those at Wolverhampton with the Lorain system, over the same period. The costs per car-mile are set forth below:—

LINCOLN.	Pence per Car-mile.
Traffic expenses, total	2·512
General expenses, total	1·476
Repairs and maintenance—	
Permanent way	0·038
Electrical equipment of line	0·133
Cars (including electrical equipment)	0·679
Buildings and miscellaneous	0·068
	0·918
Power expenses—	
Cost of current at 1½d. per B.T.U	1·797
TOTAL COSTS, EXCLUDING CAPITAL CHARGES	**6·698**
Interest, &c.	2·014
Redemption of debt	2·400
TOTAL COSTS, INCLUDING CAPITAL CHARGES	**11·112**

WOLVERHAMPTON.	Pence per Car-mile.
Operating costs—	
Electricity	1·843
Total	4·33
General charges, total	0·823
Maintenance and repairs—	
Permanent way	0·155
Feeders and conduits	0·007
Rolling stock	0·383
Buildings	0·02
Tools	0·025
	0·590
Lorain equipment—	
Track equipment	0·135
Car equipment	0·217
	0·352
TOTAL COSTS, EXCLUDING CAPITAL CHARGES, RENEWALS, &c.	**6·095**
Renewals account—	
Permanent way (as per Borough Surveyor's estimate)	0·676
Rolling stock (as per Electrical Engineer's estimate)	0·393
Lorain track equipment, ditto	0·16
Lorain car equipment, ditto	0·088
	1·317
TOTAL COSTS, INCLUDING RENEWALS, but not including CAPITAL CHARGES	**7·412**
TOTAL COSTS, INCLUSIVE OF CAPITAL CHARGES	**10·2**

L. H. W.

1427. *London Tube Railways' Accounts.* (Electrician, 60. pp. 123–124, Nov. 8, 1907.)—A detailed analysis for the first half of 1907. The totals under each head as regards working expenses in pence per car-mile are here reproduced (with the exception of the Metropolitan Railway for which only the totals are given):—

	Central London.	City and South London.	Baker Street and Waterloo.	G.N. Piccadilly and Br.	Met. District.	G.N. and City.
Miles of route	6·48	7·25	4·7	9·0	28·3	3·41
Passengers per car-mile	5·04	3·86	6·88	4·08	3·42	7·42
	Pence per Car-mile.					
Maintenance, total	0·264	0·121	0·359	0·353	0·762	0·212
Repairs and renewals, total	0·365	0·297	0·438	0·313	0·683	0·206
Traffic expenses—						
Lift working	0·314	0·391	0·596	0·678	—	0·260
Current	1·272	1·028	1·785	1·662	1·820	1·757
Total	3·248	2·456	4·953	4·629	3·208	3·868
Sundry, total	1·489	0·518	1·178	0·909	1·119	1·012
Total working expenses	5·366	3·392	6·928	6·204	5·772	5·298
Total revenue	9·841	7·099	10·468	8·725	8·239	10·729

L. H. W.

1428. *London County Council Tramways Accounts.* **H. M. Sayers.** (Elect. Engineering, 2. pp. 751–754, Nov. 14, 1907.)—An analysis of the accounts for the year ending March 31, 1907. The chief statistical figures and main heads of the revenue expenditure are given below:—

Car-miles run........................	16,267,579
Passengers carried	183,062,063
Traffic revenue	£810,390
Total revenue........................	£829,259
Units used per car-mile	2·02
Average car-miles per day per car	106
Average speed, miles per hour	8½
Average number of cars in use.........	420
Average car-hours per day............	15
Number of cars in stock..............	671
Average traffic revenue per car-mile ..	11·95d.
Average total revenue per car-mile	12·23d.
Average working expenses per car-mile	7·06d.
Average power cost per car-mile......	1·37d
Percentage of working expenses to receipts	57·70
Average fare paid per passenger	1·06d.
Average number of passengers per car-mile	11·25
Average car-miles per route mile (taken at 40 equivalent)	406,689
Average passengers per route mile (taken at 40 equivalent)	4,576,552
Average total annual receipts per route mile (taken at 40 equivalent)	£20,731

	Per Car-mile run. d.		£	s.	d.
Power expenses	1·37		92,865	5	10
Traffic expenses	3·45		234,105	7	4
Advertisement expenses	0·05		26,099	5	8
Repairs—					
Permanent way	0·41	1·29	27,688	10	0
Electrical equipment of line	0·05		3,649	1	0
Cars.................	0·75		50,614	10	5
Buildings, depôts, and tools	0·07		4,896	7	9
Miscellaneous	0·01		934	3	5
General expenses—					
Salaries, stores, rents, central office, &c...	0·36	0·81	24,523	18	11
Rates and taxes	0·10		6,746	1	9
Rates on permanent way..............	0·35		23,509	13	5
Special charges	0·09		6,063	6	6
	7·06d.		478,418	11	0
Balance, surplus on working	5·17		350,839	19	5
Total receipts..	12·23d.		£829,258	10	5

Of the £350,839 19s. 5d. surplus on working £334,211 14s. 2d. is absorbed by total debt charges, tax, &c. L. H. W.

1429. *Estimation of Traffic on Electric Tramways.* **W. Mattersdorff.** (Elektrotechn. Zeitschr. 28. pp. 1045–1046, Oct. 24, 1907. Extract of Dissertation, Berlin. Écl. Électr. 53. pp. 390–393, Dec. 14, 1907.)—From an analysis of certain German and American tramway statistics, the author arrives at the following conclusions: Considering, in the first place, the tramway traffic in towns of different sizes, the number of passengers carried per year is found to increase with the square of the number of inhabitants up to towns with a population of 500,000. For larger towns the number of passengers per year is directly proportional to the population. The average figure for towns with half a million inhabitants and upwards is 184 passengers per annum. Considering next the growth of the traffic in individual cities, the number of passengers carried, with one exception (Chicago), increases with the square of the number of inhabitants. In the case of Chicago, the traffic increases directly with the population. All the above relations are expressed in the form of curves, and curves are deduced showing the relation between the number of passengers per inhabitant and the population; in the case of Chicago, this number remains practically constant at 165 passengers per inhabitant per year. In all the other cases the number increases with the increasing population, but in varying proportion.

TABLE SHOWING GROWTH OF TRAFFIC WITH POPULATION.

Town or City.	Population in Millions.	Passengers carried per year in Millions.	Passengers carried per year per Inhabitant.
New York	1·0	20	20
	2·0	400	200
	3·0	860	290
	4·0	1,450	360
Berlin	1·0	20	20
	2·0	220	110
	3·0	700	230
Chicago	1·4	230	165
	2·0	330	165
	2·4	400	165
Dresden	0·25	10	40
	0·35	25	70
	0·5	75	150

The number of car-km. is found to increase with the population in a similar manner to the number of passengers carried. The car-km. *per inhabitant*, however, appears to reach a maximum when the population reaches some 1·5 million inhabitants. The traffic in the busiest month is found to be about 110 to 120 per cent. of the average monthly traffic. A diagram giving the hourly variation in the number of passengers carried for the New York Elevated and Berlin Tramways is also given. H. M. H.

1430. *Improvement in Electrical Power Transmission for Motor Vehicles.* (Brit. Pat. 14,079 of 1907. Engineer, 104. p. 458, Nov. 1, 1907. Abstract.)—The Felten and Guilleaume-Lahmeyerwerke have patented a method whereby the adhesive weight in the case of a train may be increased without increasing the weight of the train. The prime mover furnishing the power is coupled to a shaft carrying two armatures, whose fields are rigidly connected

to one pair of driving wheels. Each of the remaining axles of the vehicle or train is driven by a motor, the armatures of the motors being supplied with current from the two generator armatures driven by the prime mover. The fields and armatures of the generators form an electromagnetic coupling by means of which power is transmitted to the pair of wheels coupled to the generator fields. A. H.

1431. *Hardness of Corrugated Rails.* **G. L. Fowler.** (Street Rly. Journ. 30. pp. 506–508, Oct. 5, 1907.)—Gives diagrams showing the variations of height and of hardness in the length of some corrugated rails. There appears to be no connection between the variations in hardness and the positions of the corrugations. In one case (girder rail from Boston Elevated Railroad) the variations in hardness were rather more pronounced, hard spots occurring in places. These, however, are considered to be due to hardening in service, but not to an original property of the steel. The method of making the hardness tests was that investigated by Martel, in which a loaded punch is allowed to fall on the specimen and the reciprocal of the volume (V) of metal displaced is taken as a measure of the hardness. The hardness number is Wh/V, where $W =$ total weight of punch and head to which it is attached, and h is the height of fall. The scale has been standardised by the French Government, the standard punch being a four-sided pyramid, one pair of opposite edges making an angle of 60°, and the other 9°, with one another. F. R.

ELECTRIC LAMPS AND LIGHTING.

1432. *"Newarc" Thermal Lamp.* (Electrician, 60. p. 24, Oct. 18, 1907.)—In this lamp, a thermally expansible steel band, with eyes at its ends, is arranged in U-form over a porcelain pulley, one end being hooked on to a pin on a fixed insulated terminal and the other end on to a pin on a lever to which a spring is attached so as to keep the band in tension. To this lever is also attached one end of a chain which extends over a rotary brake-drum, and the other end of which is attached to a flat spring on the upper disc of the lamp frame. This brake drum is mounted on the same arbor as two pulleys over which cords extend that are respectively attached to the upper carbon holder and to a vertically guided weight whereby the carbons are normally held apart. The parts are so arranged that, when the band expands, under the thermal action of the current, the lever to which it is attached is turned by its spring, and the brake chain is pulled tight so as to grip and turn the brake drum and so strike the arc, the flat spring on the lamp frame yielding downwards as required. If the current exceeds a predetermined value, the flat spring is drawn down on to a fixed contact connected to the insulated fixed end of the band. By this means the band is short-circuited and thus protected against damage. The original paper is well illustrated. C. K. F.

1433. *Angold's Flame Arc Lamp.* (Brit. Pat. 28,012 of 1906. Elect. Engineering, 2. p. 684, Oct. 24, 1907.)—In this lamp, which is a differentially wound inclined carbon lamp, the rocking lever actuated by the solenoids

bears a contact which short-circuits the lamp and its series coil through an equivalent resistance when the current has dropped and the voltage has risen a predetermined amount. This causes the carbons to be released and to fall together. By thus diverting the current from the carbons whilst the latter are moving relatively to their clutch-tubes, sparking is entirely prevented between the carbons and their clutch-tubes. The upper contact, with which the contact on the rocking lever engages, is supported on a dashpot-piston, so that when the lower contact descends as the arc is struck the descent of the upper contact is delayed, but it is allowed to fall to a position lower than the point where contact was broken. By this means, the next contact for the purpose of throwing in the resistance, and thus sufficiently dropping the voltage to destroy the arc, can be made a little in advance of the position where the feed occurs in the descent of the carbons. This dashpot support of the upper contact, moreover, enables the resistance to be disconnected before the carbons are again gripped or parted after coming together for re-striking. The rocking lever above mentioned is connected to the clutch tubes through a link which actuates a lever fulcrumed at one end and connected to the clutch-tubes. The original paper is illustrated. C. K. F.

1434. *Siemens' Negative Electrode for Projector Lamps.* (Brit. Pat. 15,838 of 1907. Elect. Engineering, 2. p. 597, Oct. 17, 1907.)—In this lamp the positive carbon is controlled by the lamp mechanism in accordance with the voltage or the current. The negative carbon, however, is simultaneously advanced and rotated by means of clockwork. A mechanism for this purpose is described and illustrated. This consists of a fixed helix or spirally slotted tube, into the spiral slot of which engages a lateral pin attached to the lower end of the carbon and acting like a nut. This pin also engages a vertical slot in a tube rotatably mounted around the helix and turned by a clockwork train, so as to screw the negative carbon up as it rotates. C. K. F.

1435. *Steinmetz's Electrode for Luminous Flame Arc Lamp.* (Electrical World, 50. p. 845, Nov. 2, 1907.)—This forms the subject of C. P. Steinmetz's U.S. Pat. 868,502, and consists in forming the electrode (generally the negative), in which the pool of molten metal occurs, of a mixture consisting of a practically homogeneous body interspersed with refractory granules of $\frac{1}{32}$ in. to $\frac{1}{16}$ in. in diam., *e.g.*, it may consist of powdered magnetite and tantalum intermixed with granules of chromite. When the pool of liquid is formed these granules project above the surface and serve to centre the air-blast produced by the arc; except for the relatively infrequent transitions of the arc from one granule to another, the arc flame remains absolutely steady instead of forming a depression which moves rapidly about the surface of the pool as heretofore. C. K. F.

1436. *Metallised Incandescent Lamp Filaments.* (Electrical World, 50. p. 845, Nov. 2, 1907.)—Of these two filaments, both due to E. McOuat and H. W. F. Lorenz (U.S. Pats. 869,012–13), one is made by dipping a carbonised core into a caramel solution containing finely-divided metallic light-emitting particles in mechanical suspension, the coat thus deposited on the core being then carbonised. By this means finely-divided metals, including oxides or nitrides, are cemented together by particles of carbonaceous matter and form a continuous coat. In the other filament, a metal and silicon react to form a silicide in the filament itself. For this purpose a quantity of silicon and

a metal, both in a finely-divided state, are mixed with the usual filament cellulose material when in a plastic state, the amount being about 50 per cent. of the plastic mass. The filament is then squirted and treated as usual, the heat when it is brought to incandescence serving to bring about the reaction which produces the silicides. C. K. F.

1437. *The Tantalum Lamp with High Resistance Filament.* **L. H. Walter.** (Electrician, 60. pp. 199–200, Nov. 22, 1907.)—The wire of a 100-volt tantalum lamp, heated by a current in nitrogen at 15 mm. pressure had its resistance increased from 51 ohms (cold) to 190 ohms (cold) [see Abstract No. 1215 (1907)]. To the eye the metallic lustre of the filament was slightly diminished. The wire was found to be brittle in the extreme. Microscopic examination showed that the metallic lustre and uniform surface of the untreated filament had changed into bright and dull irregular patches, whilst the fracture of the treated filament was coarse crystalline in place of fine granular. It would appear, therefore, that the process described does not furnish a result which is of use to the incandescent lamp industry, unless some method be found for restoring the ductility, which, together with its high melting-point, is the chief factor making for success of the tantalum filament. It is stated that an electrical property of pure Ta, to be described elsewhere, in which the metal resembles iron in its behaviour, is destroyed by the nitrogen treatment. The author regards favourably the proposal [Abstract No. 1459 (1906)] of using a high efficiency metal filament in series with a carbon filament in the same bulb. An advantage of this arrangement, which appears not to have been pointed out, is that, by proper proportioning, the positive and negative temperature coefficients would permit the attainment of a lamp taking practically the same current at starting as when hot. This can still more simply be arrived at on 200 or higher volt circuits, by using, in place of two metallic filament lamps in series, one carbon (preferably "metallised") and one metal filament lamp in series, in the special fittings now made for tantalum lamps on high voltage circuits. F. R.

1438. *Flickering of Metallic Filament Glow-lamps.* **F. Niethammer.** (Elektrotechnik u. Maschinenbau, 25. p. 916, Nov. 24, 1907.)—The author has frequently noticed that metallic filament lamps are much more liable to flicker with small and rapid fluctuations of voltage than carbon filament lamps. This is readily accounted for by the smaller thickness and heat-capacity of the metallic filament. The effect may be readily observed by mounting a disc with a white cross painted on it on the shaft of an induction motor, and illuminating the rotating cross, first by means of a carbon, and then by means of a metallic filament lamp. In the former case, the cross appears so much blurred as to be practically invisible, while in the latter the rotation of the cross is clearly perceptible. The author is inclined to think that it will be impossible to run metallic filament lamps satisfactorily on a 25-$\sim$ circuit. A. H.

1439. *Tests of "Osram" Lamps.* **Benisch.** (Elektrotechn. Zeitschr. 28. p. 1116, Nov. 14, 1907. Paper read before the Dresdener Elektrotechn. Verein.)—A brief notice of some tests of 110-volt 32-c.p. "osram" lamps. The tests were made after 400 hours' running in the case of direct current and after 400–500 hours on alternating current. On direct current the initial mean horizontal c.p. was 33·5 hefners (1·08 watts per candle), and after 400 hours 32·2 hefners (1·18 watts per candle). The results with 4 lamps on alternating

current are given below and show a mean consumption of 1·01 watts per candle :—

	Voltage.	Current, amp.	Watts.	Mean Horiz. c.p. (hefners).	Watts per candle (hefner).
I.	110	0·364	40	40·6	0·99
II.	110	0·315	34·6	32·4	1·07
III.	110	0·325	35·8	39·3	0·91
IV.	110	0·327	36	33·6	1·07

The spherical luminous intensity of an "osram" lamp whose mean horizontal intensity was 32 hefners was found to be 25·7 hefners, whilst the lower hemispherical intensity was 26·7. L. H. W.

1440. *Recent Incandescent Lamp Developments.* F. W. Willcox. (Elect. Rev., N.Y. 51. pp. 396–402, Sept. 14, 1907.)—The "metallised" carbon, or "gem," filament is dealt with at some length, and magnified views of the filament at different stages of the process are given. The decrease in specific resistance of the filament due to metallising is well shown by the following table :—

	Sp. Resistance Cold.	Sp. Res. at 3·1 Watts per Candle.
Base carbon not metallised	25,500	14,460
" " metallised	24,900	10,460
Graphite shell not metallised	3,840	1,715
" " metallised on a base not previously metallised	514	1,288
Graphite shell metallised on a base previously metallised	954	1,580

The American-made tantalum lamps are of 50 and 80 watts, the former to replace the 16-c.p. carbon lamps and giving 50 per cent. more light for the same cost, the latter as substitute for the 32-c.p. lamp, and giving 25 per cent. more light with 25 per cent. less energy ; or as substitute for 100-watt "gem" filament lamps and giving the same c.p. (with similar reflectors) with 20 per cent. saving in energy. The hardiness and durability of the tantalum lamp and the possibility of producing lamps for 100 volts with a c.p. as low as 20 are believed to provide a special field for this lamp and ensure its continued use. As regards the tungsten lamp, these are now made by the General Electric Co. with anchored filaments so that the lamp can be used in any position; but a c.p. of 40 is about the lowest practical value. The fragility of the filament is at present a drawback, but it is expected to overcome this. Illustrations are given of the low-voltage tungsten lamp for 25–30 volts, 25 watts, 20 c.p.; of the multiple, 100–125-volt, 100-watt, 80-c.p.; and of the street series lamp (40 c.p., 1·3 watts per candle). L. H. W.

1441. *Standard Specification for Glow-lamps.* J. Teichmüller. (Elektrotechn. Zeitschr. 28. pp. 1016–1018, Oct. 17, 1907. Elect. Engineering, 2. pp. 877–878, Dec. 5, 1907.)—The author makes a comparison between the standard specifications used in Germany, Austria-Hungary, and Switzerland, which greatly resemble one other, and compares same with the specifications framed by the Engineering Standards Committee in England. The general question of tests is fully discussed by the author. The study

of the rapid life-testing method for incandescent lamps as used in Austria-Hungary is recommended. By this method the lamps are run only for 24 hours at an increased voltage of 20 per cent. over the normal voltage. The results so obtained give a fair indication as to the behaviour of the rest of the lamps when used under normal conditions. The lamp manufacturers, however, do not as yet seem to accept this method as giving conclusive results for all type of lamps. It may be remarked that conditions imposed by the standard specification are to be observed in Germany only when the order of lamps of the same type exceeds 200. In Austria-Hungary the order must exceed 2,000 lamps, of which at least 200 are of the same type. In the use of the Swiss and English specifications, however, these restrictions do not exist. The author is of the opinion that strict adherence to the standard specification will considerably improve the manufacture of glow-lamps. L. G.

1442. *Production of Tungsten Filaments.* (French Pats. 379,069 and 378,748. Soc. Chem. Ind., Journ. 26. p. 1192, Nov. 30, 1907. Abstracts.)—Two patents of the Siemens and Halske A.-G. In the first, a solution of the hydrate of tungstic acid in ammonia is boiled until crystallisation commences. The crystals are heated for a time up to 250° C. and then boiled in water to obtain a plastic and tenacious mass, which can be squirted into filaments. The second patent relates to a practically identical process. L. H. W.

1443. *Reliability of Rotating Lamp Method in Photometry.* **E. P. Hyde** and **F. E. Cady.** (Bureau of Standards, Bull. 3. pp. 357–369, Aug., 1907.)—In view of the opinion expressed by Uppenborn [Abstract No. 337 (1907)] that the rotating lamp method is unreliable, the authors determined to carry out a further thorough investigation of the errors resulting from (1) bending of the filament and (2) flicker. Various types of lamps were tried, from those with anchored filaments to others with filaments entirely unsupported except at the joints. The maximum error observed due to bending did not exceed 1·5 per cent., *provided the filament did not touch the bulb.* For most common types of lamp the speed would have to considerably exceed 600 r.p.m. before contact occurred between the filament and bulb. When such contact does occur, changes in the c.p. of 6 or 7 per cent. may take place; as these large changes are always accompanied by relatively large changes in resistance, it is probable that they are due to cooling of the filament by its contact with the glass. As regards the error due to flicker, this, at speeds of 300 to 400 r.p.m., is not very great with most types of lamp; and since the error due to bending is quite small at these speeds, the authors conclude that the rotating lamp method is convenient and reliable in commercial testing. If the flicker is appreciable, the method of a single auxiliary mirror described in Abstract No. 1457 (1906) should be used. [See also Abstract No. 826 (1907).] A. H.

1444. *The Sensitiveness of Photometers.* **L. W. Wild.** (Electrician, 60. p. 122, Nov. 8, 1907.)—The results of experiments to determine the relative sensitiveness of various types of photometer are described. The photometer head was first moved towards the balance position from the right, and the reading taken. It was then moved towards the same position from the left and the reading taken. The ratio of the difference between the two readings, to the distance between the two lamps is taken as a measure of the sensitiveness. Two carbon filament lamps were first compared, one having an efficiency of 0·282 and the other of 0·280 candle per watt. One of these

lamps was next compared with an old "osram" lamp, having an efficiency 0·714 candle per watt, the illumination on the screen being 1·65 candle-ft Finally a 10-c.p. pentane lamp was compared against an incandescent gas burner, the illumination being 8·1 candle-ft. The following table gives the results of the experiments, the numbers being the sensitiveness (as above defined) multiplied by 100 :—

Photometer.	Carbon Lamps of Equal Efficiency.	Carbon and Osram, 0·28 and 0·71.	Pentane and Incandescent Gas.
Ritchie Wedge	2·4	5·0	8·2
Joly Prism (paraffin)	2·5	4·8	8·3
Lummer-Brodhun	0·7	8·5	8·0
Bunsen, single..................	1·2	8·6	8·7
Bunsen, double	1·5	5·0	9·8
Bunsen, special single	0·4	8·8	7·8
Bunsen, special double......	1·0	4·5	9·0
Trotter, badly made	8·5	6·2	11·5
Trotter, carefully made......	0·8	4·8	9·6
Simmance Abady flicker ...	1·7	1·8	2·1
Wild flicker.....................	0·8	0·8	1·0

It will be noticed that when the lights are of exactly the same colour two photometers of the stationary type are the most sensitive. When, however, the colour-difference is appreciable, as, for instance, when comparing a carbon filament lamp against a standard lamp of the same kind, both flicker photometers surpass the others. **K. Edgcumbe.** (Ibid. pp. 176–177, Nov. 15, and p. 257, Nov. 29.) **L. W. Wild.** (Ibid. pp. 216–217, Nov. 22.)

A. R.

1445. *Production of Tantalum and Niobium for Filaments by Electrolysis.* (French Pat. 377,931. Soc. Chem. Ind., Journ. 26. p. 1098, Oct. 31, 1907. Abstract.)—According to the process of G. C. Bouhard, to 100 gm. of potassium columbate (niobate) or tantalate dissolved in 8 litres of water sulphuric acid is added until no further precipitate is formed. The precipitate is filtered off after some hours, washed, mixed with 1 litre of water heated to 70°–80° C., and dissolved by adding a hot solution (1 : 5) of oxalic acid. The excess of oxalic acid is neutralised with ammonia, and, after cooling, sufficient HCl or H_2SO_4 is added to form 8 per cent. of the liquid. This solution is then electrolysed, using a current at 2 volts and 0·1–0·8 amp. The anode is of carbon or Pt, and is of rectangular form ; the kathode consists preferably of a series of horizontal wires of carbon or Pt. The deposited metal is removed from the bath when it has attained a thickness of 8 or 4 mm., and is drawn as usual into wire, 0·04–0·05 mm. in diam., which is used for lamp filaments.

REFERENCES.

1446. *Graphical Determination of Voltage Drop.* **T. L. Kolkin.** (Elect. Rev. 61. pp. 604–606, Oct. 11, 1907.)—The author explains the application of the graphical method to the determination of the voltage drop, size of conductors, and situation of substations or feeding-points in the case of a large railway or power distribution system.

A. H.

1447. *Electric* v. *Hydraulic Equipment for Docks.* **W. W. Squire.** (Inst. Civ. Engin., Conference vol. (Sect. 2), pp. 72–74; Discussion, pp. 74–100, 1907. Electrician, 59. pp. 396–397; Discussion, pp. 397–398, June 21, 1907.)—In the discussion some figures are given as to cost, both capital and working.

1448. *Electrically-driven Reversing Rolling-mills of the McKenna Process Co.* (Engineering, 81. pp. 262–266, March 2; 296–298 and 300, March 9; 375–378, March 23, and pp. 439–441 and 452, April 6, 1906. Elect. Engin. 38. pp. 474–479, Oct. 5, and pp. 515–520, Oct. 12, 1906.)—A fully illustrated account. Several features of interest are described, notably the controlling arrangements of the rolling-mill and the Hyde waste-heat boilers supplied with gases from the rail furnaces.

1449. *Cost of Pumping by Steam or Gas Engine, or by Electricity.* **C. Hawksley** and **H. Davey.** (Inst. Civ. Engin., Conference vol. (Sect. 6), pp. 8–11; Discussion, pp. 11–25, 1907. Electrician, 59. p. 382; Discussion, pp. 382–383, June 21, 1907. Engineer, 103. p. 634, with Discussion, June 21, 1907.)—The authors' estimate of costs is based upon assumed conditions as to efficiency which are challenged (as out of date) in the discussion; they should therefore be referred to in the original.
L. H. W.

1450. *Equipment at Grangesberg Iron Mines, Sweden.* **G. Ralph.** (Inst. Elect. Engin., Journ. 38. pp. 626–634, June, 1907. Abstract of paper read before the Newcastle Section. Elect. Engin. 39. pp. 226–230, Feb. 15, 1907. Elect. Rev., N.Y. 50. pp. 603–605, April 13, 1907.)

1451. *Tests of New Power Plant for Railway and Lighting Service in Waltham, Mass.* (Street Rly. Journ. 30. pp. 508–509, Oct. 5, 1907.)—An account of further tests made with the plant described in Abstract No. 820 (1907).

1452. *2,000-volt Continuous-current Railway.* **O. Schroedter.** (Elektrische Kraftbetr. u. Bahnen, 5. pp. 561–567, Oct. 14, and pp. 585–588, Oct. 24, 1907. Écl. Électr. 53. pp. 329–337, Dec. 7, 1907.)—A description of the railway noticed in Abstract No. 1314 (1907).
A. H.

1453. *Canal Electrification Methods.* **B. H. Thwaite.** (Elect. Rev. 60. pp. 124–126, Jan. 18, and pp. 162–164, Jan. 25, 1907.)—A summary of the different methods proposed and of the results obtained where these have been actually applied.

1454. *Dinin Electromobiles.* **J. A. Montpellier.** (Electricien, 34. pp. 17–21, July 13, 1907.)—The chief feature consists in the controller. This is actuated by the foot pedal usual in petrol cars, through a rack and pinion arrangement. Complete control is obtainable with both the driver's hands free. Illustrations are given.
L. H. W.

1455. *Electrical Working of Points and Signals.* **L. de M. G. Ferreira.** (Inst. Civ. Engin., Conference vol. (Sect. 7), pp. 17–21; Discussion, pp. 21–33, 1907. Electrician, 59. pp. 384–385; Discussion, pp. 385–386, June 21, 1907. Elect. Engin. 39. pp. 868–869; Discussion, p. 869, June 21, 1907.)—Deals mainly with the all-electric system with permanent control. In the discussion some information is given as to practical results with this system and the electro-pneumatic system.
L. H. W.

1456. *Brake-shoe Testing: Report of Committee of the Master Car Builders' Association.* **F. W. Sargent.** (Street Rly. Journ. 30. pp. 176–182, Aug. 3, 1907. Abstract of Report to the Master Car Builders' Assoc.)—Summarises the brake-shoe tests made by the Association during the past twelve years by the Purdue University testing plant so far as they relate to electric traction conditions [see Abstract No. 1207 (1907).]

1457. *Heyland's Cascade Single-phase Railway System.* **H. M. Hobart.** (Elect. Engineering, 2. pp. 529–582, Oct. 3, 1907.)—[See Abstracts Nos. 1291, 1817 (1907).]

1458. *Use of Porcelain for Mercury Rectifier Vessels.* (Brit. Pat. 6559 of 1906. Elektrotechnik u. Maschinenbau, 25. p. 801, Oct. 13, 1907. Abstract.)—P. Cooper Hewitt finds that by the use of a heat-resisting (Meissen) porcelain the mercury vapour is not contaminated during the running by the gas which is given off by the usual glass containing-vessels. A number of other patents relating to mercury vapour rectifiers are abstracted on the same page. L. H. W.

1459. *Instrument for Testing Mechanical Perfection of Arc Light Carbons.* **C. Richter** and **H. Häser.** (Elektrotechnik u. Maschinenbau, 25. pp. 342–344, May 5, 1907.)—After pointing out the serious disadvantages which result from the use of curved carbons, the authors describe an apparatus invented by themselves for testing the straightness of carbons, measuring their exact length, and the deviation of their cross-section from the circular form. A. H.

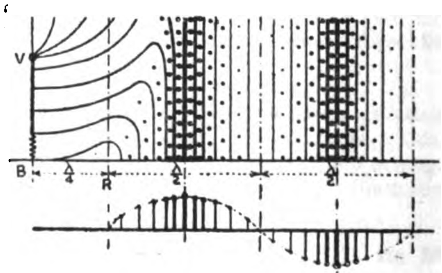
1460. "*Germania*" *Reflector Lamp.* (Elect. Rev., N.Y. 51. pp. 453–454, Sept. 14, 1907.)—In this lamp the silvering is coated with metallic copper by a secret process. Photometric curves are given of three lamps (*a*) with the bulb clear, (*b*) with the bulb silvered, and (*c*) with the bulb silvered and frosted. C. K. F.

TELEGRAPHY AND TELEPHONY.

1461. *Electric Oscillations produced with a Spark-gap in Hydrogen.* **K. E. F. Schmidt.** (Phys. Zeitschr. 8, pp. 617–618, Oct. 1, 1907.)—The author has already pointed out the utility of a hydrogen atmosphere for the spark-gap for laboratory use [Abstract No. 1899A (1907)]; but when this device is used for wireless telegraph purposes it is found to give rise to a much greater damping [as has already been pointed out by Hahnemann and v. Traubenberg, Abstract No. 1222 (1907)], besides which the waves are less effective at the receiver. The experiments were, however, carried out with a distance of only 850 m. between transmitter and receiver. L. H. W.

1462. *Arrangement for using Oscillation Valves as Receivers in Wireless Telegraphy.* (Brit. Pat. 887 of 1907. Engineer, 104. p. 510, Nov. 15, 1907. Abstract.)—G. Marconi and Marconi's Wireless Telegraph Co. have patented the following arrangement, employing Fleming's oscillation valve. The valve is in series with the secondary of the jigger and also with the secondary of a 10-in. induction coil, the primary of the coil being connected to the telephone or to a relay. A condenser is placed between the coil and the valve, and another, of suitable capacity, in shunt to the jigger secondary. A diagram of connections is given, but no explanation of the possible advantages of the arrangement. L. H. W.

1463. *Non-earthed Closed Circuit for receiving Wireless Telegraph Signals.* **O. C. Roos.** (Electrician, 59. p. 921, Sept. 20, 1907.)—The writer points out that Pickard's statement [Abstract No. 970 (1907)] that "the magnetic component is 90°, or a quarter wave-length behind the electric component," is incorrect, except at the source. They coincide in phase, as Stokes and



Maxwell have shown, as soon as they have got about a quarter wave-length from the oscillator. In a conductor, on the other hand, a pure plane wave has its electric component always 45° ahead of the magnetic, to keep the balance of the energies of the fields. The Fig. shows a correct representation of the circumstances; strictly speaking, however, the dots should be threaded on their supporting electric lines. [The electrical component is shown in full line; the magnetic component as a series of dots.] J. E.-M.

1464. *Regular Transatlantic Wireless Service.* **R. A. Fessenden.** (Electrician, 60. pp. 200–203, Nov. 22, 1907. Elect. Rev. 61. pp. 886–889, Nov. 22, 1907.)—The author points out that though no proper technical descrip-

tion has as yet been given, the information furnished to the Press by the Marconi Co., that regular commercial working had been accomplished, and that a speed of 20 words per min. was attained, is misleading. He then reproduces a number of the messages picked up at Brant Rock, which tend to support his contention, and also show that atmospheric troubles are still not overcome. **H. C. Hall.** (Ibid. p. 255, Nov. 29.)—Hall, on behalf of the Marconi Co., replies to the above, but, as the Editor points out in a footnote, does not refute the sample messages. [See also editorial, ibid. p. 198.]

L. H. W.

1465. *Producing Signals with the Poulsen Arc.* (Brit. Pat. 28,602 of 1907. Engineer, 104. p. 304, Sept. 20, 1907. Abstract.)—This invention of V. Poulsen relates to a method of varying the intensity of the oscillations in the circuit in shunt to the arc, by regulating the supply of gas (hydrogen, &c.) to the arc. This regulation may be effected by means of a perforated tape passing across the gas supply pipe, the perforations being of the kind used in automatic signalling. L. H. W.

1466. *Atlantic Wireless Telegraph Station for the Poulsen System.* (Elect. Engineering, 2. pp. 765–766, Nov. 14, 1907.)—The station is to be at Knockroe on the shores of Tralee Bay. The aerial system is to comprise a cone of 300 wires spreading over some 70 acres, supported on 12 masts. Nine 70-ft. masts are arranged in a circle 2,000 ft. in diam. The three other masts, each 360 ft. high, are placed as a triangle within this circle. The power available in undamped radiation is to be about 10 or 15 kw. when the station is completed. The condensers are to have air as dielectric, and the inductances are stated to be designed so as to be of very low resistance. The frequency is to be about 100,000 per sec., corresponding to a wave-length of about 3,000 m. Photographs are given of the masts in process of erection.

L. H. W.

1467. *Glace Bay Wireless Telegraph Station.* (Electrical World, 50. pp. 955–956, Nov. 16, 1907.)—The Marconi high-power transatlantic station. Four towers 215 ft. high with poles 50 ft. high surmounting them are used. The aerial wires (about 50) run from the top of the poles nearly horizontally for several hundred feet in a westerly direction. The plant comprises a 500-h.p. Browett condensing steam engine direct coupled to a 350-kw., 3-phase alternator, generating at 2,000 volts. It is stated that only 70 kilowatts is used for transmission, with which power the signals are so strong as to preclude any possible interruption of the service by atmospherics. [See, however, Abstract No. 1464 (1907).] L. H. W.

1468. *Wireless Telephony.* **R. A. Fessenden.** (Electrician, 59. pp. 985–989, Oct. 4, 1907. Elect. Rev., N.Y. 51. p. 768, Nov. 9, 1907.)—The author describes the arrangements and apparatus of the National Signalling Co. for wireless telephonic communication between Brant Rock and New York (350 km.). The generator is a 1-kw. steam turbine-driven alternator, giving currents of frequency 81,700 to 100,000 per sec., at 150 volts. The resistance of the disc armature is 6 ohms, and the field exciting current 5 amps. Experiments are in progress with a 270-volt generator of 2 kw. output, and machines of 10 and 50 kw. are being built on the same principle. Using the 200-ft. New York antenna and the Atlantic tower at Brant Rock, about 200 watts in the antenna is required for the 350 km. L. H. W.

1469. *Wireless Telephony on the "Telefunken" System.* **C. Schapira** and **S. Löwe.** (Elect. Engineering, 2. pp. 725–726, Nov. 7, 1907. From the German.)—A brief note on the methods employed by the Gesell. für Drahtlose Telegraphie. A station at the Charlottenburg Technical Hochschule provided with a T-antenna of three parallel 50-m. wires 1 m. apart (masts 18 and 10 m. high) is able to speak with a portable station, fitted with an umbrella aerial, and counterpoise, with mast 20 m. high, up to 30 km. distance. The energy employed is 800 watts (3·6 amps. at 220 volts), six arcs in series being used. L. H. W.

1470. *Converter for supplying Currents to Telephone System.* (Elect. Engin. 40. p. 652, Nov. 8, 1907.)—The British Thomson-Houston Co. have recently patented a special form of converter which is intended to supply current to a telephone system. The converter consists of a homopolar (unipolar) machine which may be driven from lighting mains, the low-voltage currents for the telephone system being derived from a few of the conductors only, by using the slip-rings between which the conductors are included. The general construction of the converter is similar to that of Noeggerath's machine [Abstract No. 218 (1906)]. A. H.

REFERENCES.

1471. *Telegraphic Transmission of Photographs.* **A. Korn.** (Elektrotechn. Zeitschr. 28. pp. 808–810, Aug. 15, 1907.)—The author describes experiments carried out on a telephone line connecting Berlin and Munich with his system of transmitting photographs. With the selenium compensator arranged in the transmitter, very satisfactory results were obtained. Stations are to be established in Berlin, Munich, Paris, and London for working this system [see also Abstract No. 465 (1907)]. A. H.

1472. *Seasoning of Telegraph and Telephone Poles.* **H. Grinnell.** (Elect. Rev., N.Y. 51. pp. 256–259, Aug. 17, 1907. From a circular of the U.S. Dept. of Agriculture, Forest Service.)—Based on a life of twelve years, it is estimated that 2,250,000 poles are required per year. Tables are given of weight and percentage of moisture of white cedar and of chestnut poles, and the rate of and loss in seasoning as well as the shrinkage. L. H. W.

1473. *Wireless Telephony.* **R. A. Fessenden.** (Electrician, 59. pp. 484–487, July 5, 1907.)—In a letter in which the attack on Fleming's book is continued [Abstract No. 841 (1907)] illustrations are given of some of the apparatus employed in the author's experiments. For de Forest's experiments (up to 12 miles) see West. Electn. 41. pp. 62–68, July 27, 1907. The patents of de Forest and of J. S. Stone, owned by the Fiscal Agency Co., of New York, are briefly reviewed in Elektrotechn. Zeitschr. 28. p. 796, Aug. 8, 1907, and their novelty and utility destructively criticised. L. H. W.

1474. *The Pupin Mode of Working Trunk Telephone Lines.* **W. H. Preece.** (Electrician, 59. pp. 671–674, Aug. 9, 1907. Paper read before the British Assoc., at Leicester, Aug. 5, 1907. Elect. Engin. 40. pp. 237–238, Aug. 16, and pp. 260–268; Discussion, p. 268, Aug. 23, 1907.) **B. S. Cohen.** (Ibid., pp. 689–690.)—A criticism of some of the author's conclusions.

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[*Names not followed by Titles are not Authors, but only names mentioned in Abstracts. The numbers refer to Abstracts, those in Italics referring to References. An asterisk indicates remarks in a discussion.*]

SUBJECT INDEX.

SECTION B.—ELECTRICAL ENGINEERING.

To facilitate reference to any desired subject, the Index is divided into the following sections arranged alphabetically. If any of these are absent this may be taken as an indication that no Abstracts dealing with those particular subjects have been included in this volume.
The numbers refer to Abstracts, those in italics referring to References.
An asterisk indicates remarks in a discussion.

In Steam Plant, Gas and Oil Engines:—Accessories (steam plant); Automobiles; Boilers; Condensers, Economisers, Feed Water Heaters and Superheaters; Gas Engines, Gas Producers, &c.; Miscellaneous; Oil Engines; Steam Engines; Airships and Balloons.
In General Electrical Engineering:—Accessories and Appliances (electrical, excluding traction); Apparatus and Instruments (descriptive); Batteries (primary); Batteries (secondary); Equipment of Factories, Mines, &c.; Insulation and Insulators; Machine Tools, Cranes and Elevators, &c.; Materials of Construction (excluding Metals), their properties and treatment; Metallography and Properties and Treatment of Metals; Miscellaneous; Water-power Plant.
In Generators, Motors, and Transformers:—Alternators; Dynamos; Miscellaneous; Motors; Rectifiers; Transformers and Rotary Converters.
In Power Transmission, Traction, and Lighting:—Accessories and Appliances (traction); Automobiles (Electric); Cables, Conductors, and Wiring; Costs; Electricity and Traction Works (descriptive); Lamps (arc) and Arc Lighting; Lamps (incandescent) and Lighting by Incandescent Lamps; Miscellaneous; Power Transmission and Distribution; Traction (electric, by accumulators); Traction (excluding accumulator traction and descriptions of power stations); Traction (mechanical).
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